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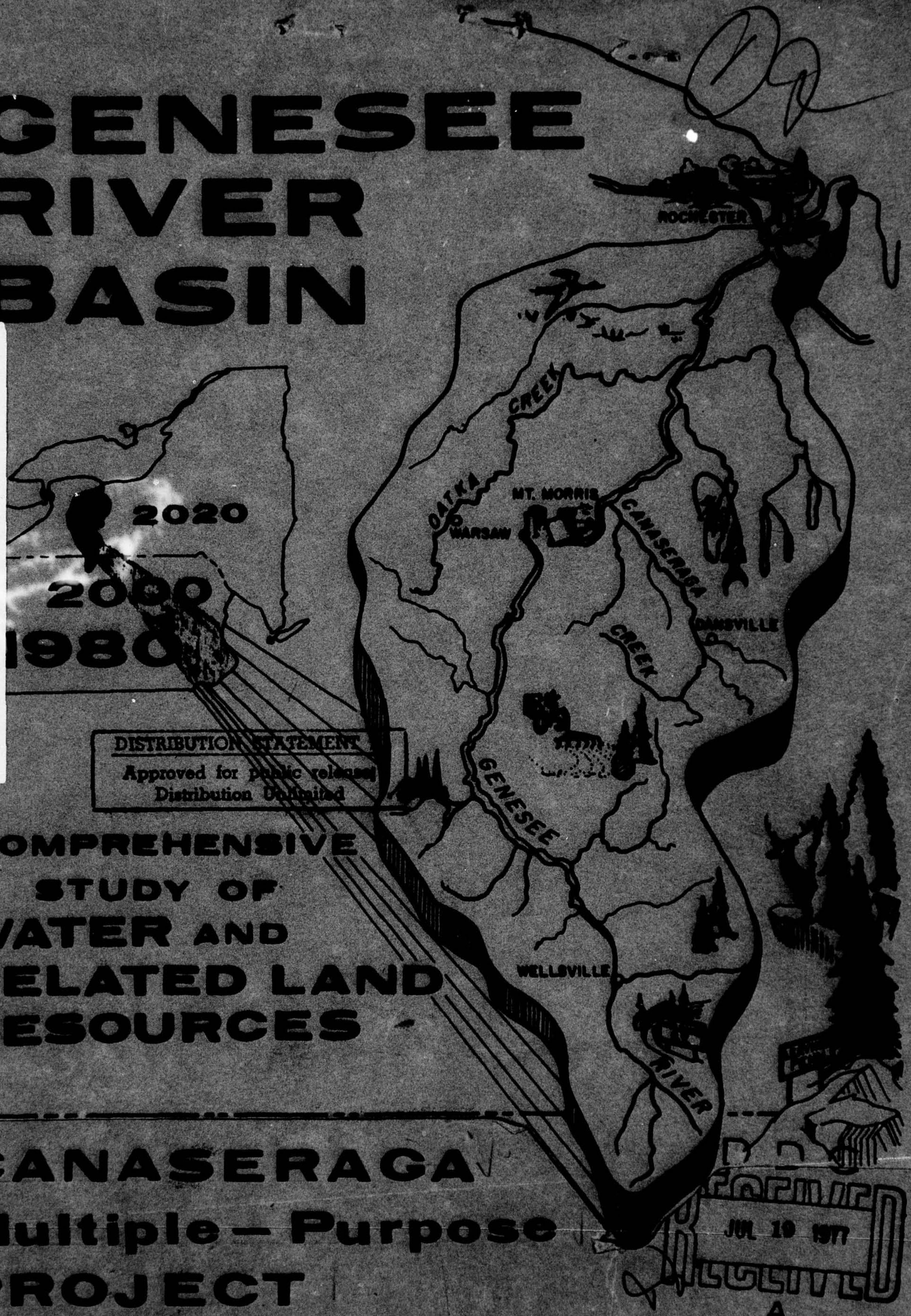
GENESEE RIVER BASIN



COMPREHENSIVE STUDY OF WATER AND RELATED LAND RESOURCES

CANASERAGA Multiple-Purpose PROJECT

(6) Genesee River Basin Comprehensive Study of Water and Related Land Resources. Canaseraga. Multiple-Purpose Project.

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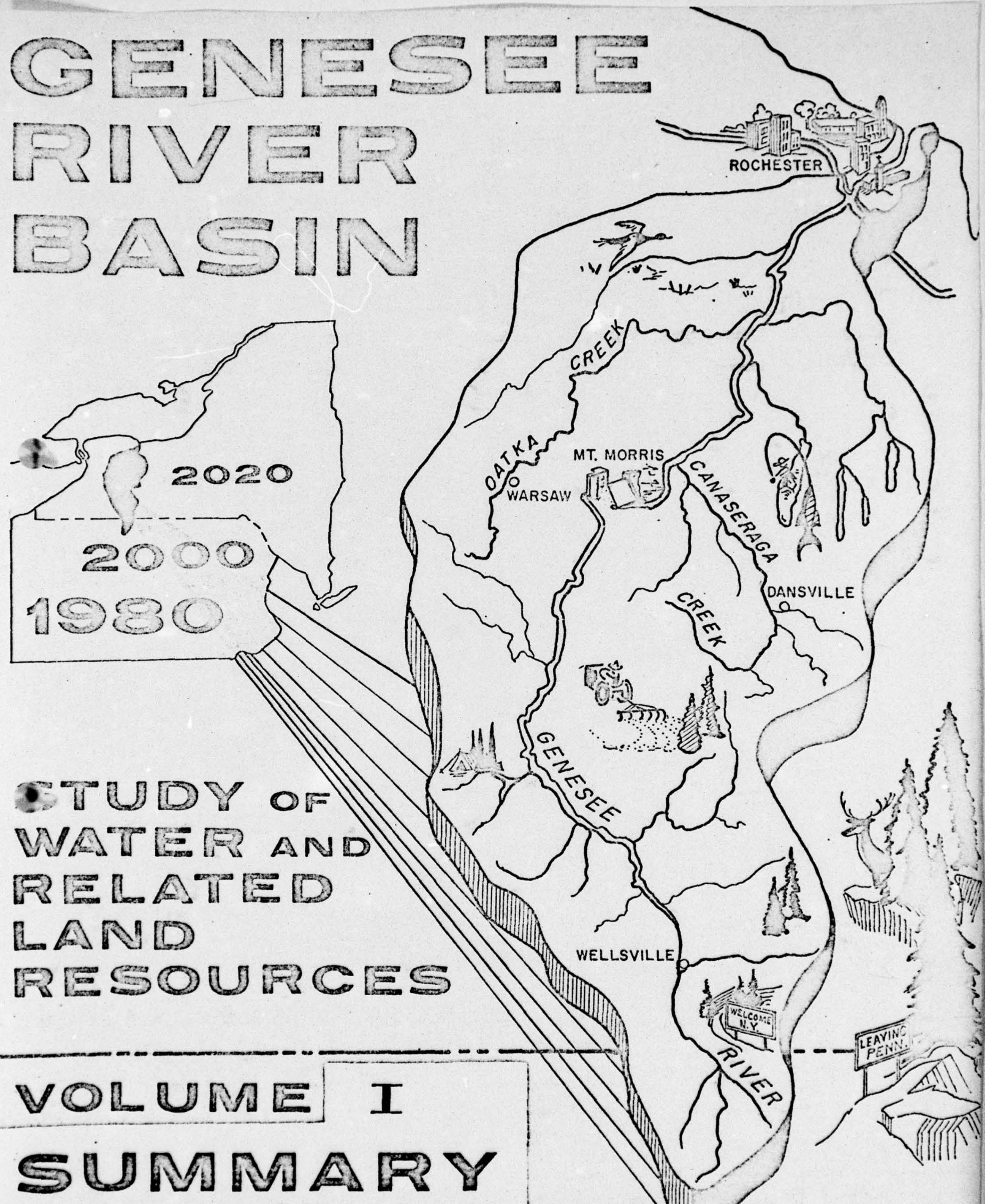
GENESEE RIVER BASIN



STUDY OF WATER AND RELATED LAND RESOURCES

VOLUME I

SUMMARY REPORT

176. The Canaseraga Valley, a rich agricultural area, was investigated in the study jointly by the Corps of Engineers and the Soil Conservation Service. Several alternative structural plans were developed as follows:

a. Poag's Hole Reservoir;

b. Tuscarora Reservoir;

c. Poag's Hole and Tuscarora Reservoir as a system;

d. ~~A~~ system of six Soil Conservation Service reservoirs;

e. ~~A~~ system of S.C.S. reservoirs in conjunction with Poag's Hole and Tuscarora Reservoirs;

f. ~~C~~hannel enlargement; and

g. ~~C~~hannel enlargement with a barrier leeve.

A feasible project to give five year summer protection to the valley was developed by the combination of channel enlargement and a barrier leeve across the valley. The project is explained in detail in Appendices "B" and "C".

214. CANASERAGA PROJECT

Canaseraga Creek is the largest tributary of the Genesee River with a drainage area of 335 square miles at the mouth. It is located in the Lower Genesee Basin and joins the Genesee River about 4 miles downstream of Mount Morris Dam. The upper reaches of the Canaseraga are steep and rugged. The lower reach is a flat alluvial agricultural plain approximately fifteen miles in length and from one to three miles in width. This lower reach is inundated to some extent annually by streamflow exceeding the channel capacity and poor local drainage. This poorly drained area provides temporary habitat for thousands of waterfowl during their spring and fall migration periods. Flood damages in the valley are agricultural in nature and inundation has been known to last for several months. The proposed project is described in survey scope detail in Part IV, Appendix "C," Project Designs and Cost Estimates.

215. Several alternative plans of development were considered. These alternative plans are listed in paragraph 176. The plan consisting of channel improvement with a barrier leeve for both 5-year and 10-year flood protection was investigated. The 5-year multiple-purpose project provided the best benefit-cost ratio. The basis of design for this plan of improvement is as follows:

a. Protect the Canaseraga Valley from Shakers Crossing upstream to White Bridge from flooding from the 5-year discharge on the "summer event" basis;

b. Sufficiently reduce the duration of flooding in the existing

ponding area upstream of Keshequa Creek to assure the farmers use of this land by a certain date a percentage of the years;

c. Provide a control at the lower end of the improvement to limit the discharge from the valley to that discharge that would have occurred under existing conditions and thereby produce no greater damage on the lower Genesee Basin due to discharge from Canaseraga Creek than would have occurred under existing conditions; and

d. Provide both permanent ponding areas and a temporary spring ponding area for waterfowl habitat, so that the existing habitat conditions will be improved by the project.

216. The average annual benefits and costs that can be expected to accrue from both a single and multiple-purpose project affording 5-year protection as described above, are given in table 43.

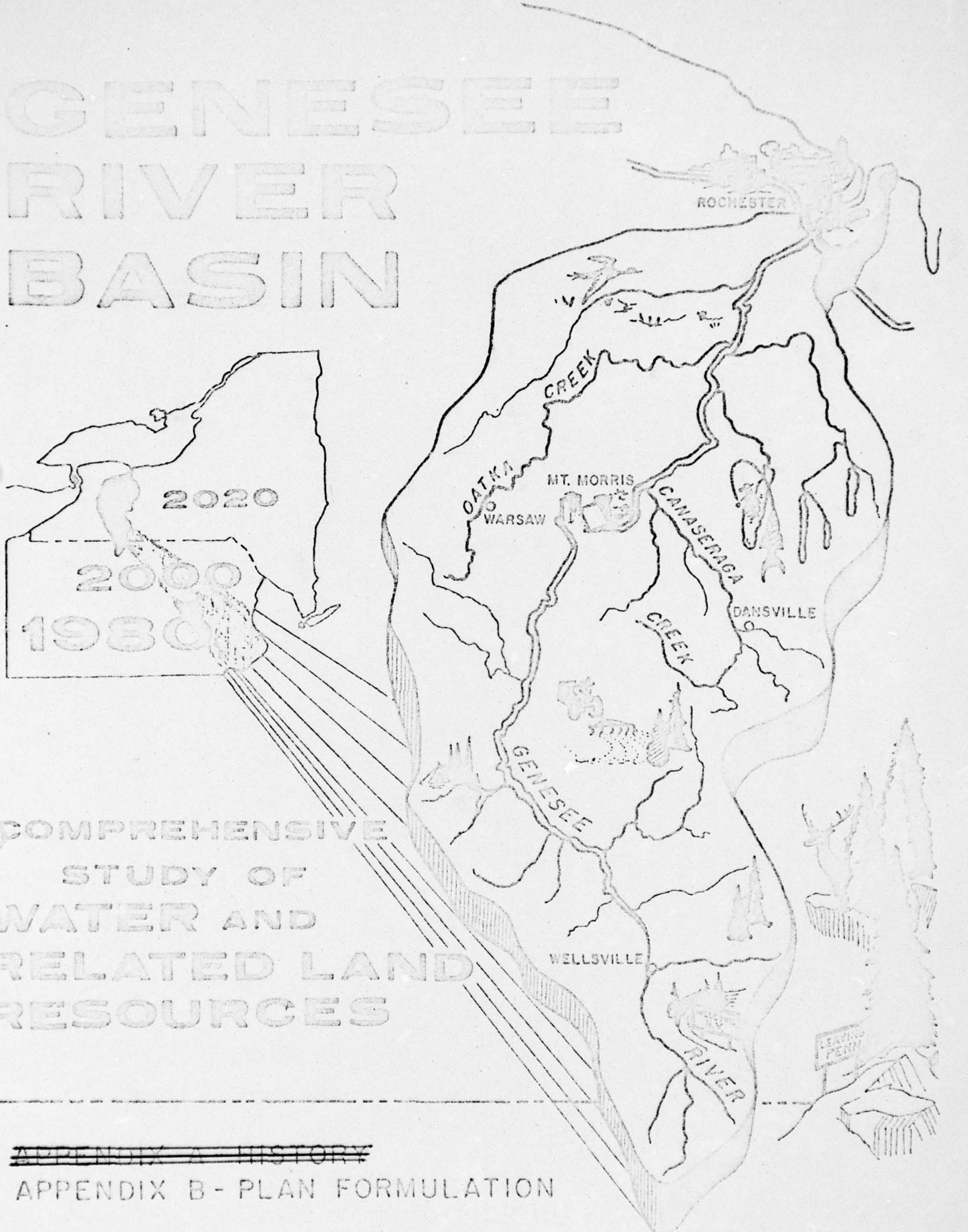
TABLE 43 - Canaseraga project, single and multiple-purpose plans

Item	Single Purpose Project: Flood Control	Single Purpose Project: Fish & Wildlife	Multiple-Purpose Project
Channel improvement, ft.	88,000	-	88,000
Retention structure, length			
Non-overflow section, ft.	9,000	-	9,000
Earth overflow section, ft.	3,500	-	3,500
Gated spillway, ft.	75	-	75
Average height, ft.	17	-	17
New bridges			
Highway	2	-	2
Farm	3	-	3
Weirs & Control structures	5	-	5
Waterfowl ponds			
2 Permanent, surface, Ac.	-	1,140	1,140
1 Temporary, surface, Ac.	-	2,000	2,000
BENEFITS			
Flood control:			
Reduction of flood losses	$ 54,900	-	$ 54,900
Changed land use	$ 33,700	-	$ 33,700
More intensive land use	$ 106,300	-	$ 106,300
Fish and Wildlife:			
Waterfowl habitat improvement (1)	-	$ 171,200	$ 171,200
Bird-watching & waterfowl hunting (1)	-	$ 26,700	$ 26,700
Total Average Annual Benefits	$ 194,900	$ 197,900	$ 392,800
COSTS			
First cost	$ 6,520,000	$3,740,000	$ 7,466,000
Interest during Construction (3-1/8%)	$ 203,800	$ 116,900	$ 233,300
Investment cost	$ 6,723,800	$3,856,900	$ 7,699,300
Annual Charges:			
Interest (3-1/8%)	$ 210,100	$ 120,500	$ 240,600
Amortization (50-years)	$ 57,400	$ 32,900	$ 65,800
Operation and maintenance	$ 21,700	$ 8,600	$ 23,700
Total Annual Charges	$ 289,200	$ 162,000	$ 330,100
Benefit-Cost Ratio	0.7	1.2	1.2

DS (1) Discounted for ultimate use, expected to develop within 20 years after completion of project.

217. The multiple-purpose plan of improvement for Canaseraga Valley is economically justifiable and provides for more needs than a single-purpose fish and wildlife project. The plan provides a feasible solution to the outstanding remaining flood problem in the Genesee River Basin and would also produce sizable additional benefits attributable to fish and wildlife interests.

GENESEE RIVER BASIN



COMPREHENSIVE STUDY OF WATER AND RELATED LAND RESOURCES

~~APPENDIX A - HISTORY~~

APPENDIX B - PLAN FORMULATION

PRELIMINARY DRAFT

48. GENERAL

Canaseraga Creek is the largest tributary of the Genesee River with a drainage area of 335 square miles at the mouth. It is located in the Lower Genesee Basin and joins the Genesee River about 4 miles downstream of Mount Morris Dam. Streams tributary to Canaseraga Creek include Mill, Sugar and Slader Creeks and Stony Brook in the upper reaches of the basin and Keshequa and Bradner Creeks in the lower reaches. Keshequa Creek, with a drainage area of 76 square miles, is the largest stream tributary to Canaseraga Creek. The Canaseraga Basin, designated Subwatershed 13 for this comprehensive study, is shown on Plate E-1 of Appendix E.

49. The Canaseraga Creek Basin approximates a square of about 20 miles on a side. The upper reaches of the basin are steep and rugged with a main stem slope of about 40 feet per mile. The lower valley, from Dansville downstream to the confluence with the Genesee River, is a flat alluvial plain with a main stem slope of about 3 feet per mile. The creek, rising at about elevation 1900, joins the Genesee River at river mile 63 at about elevation 548.

50. The area studied, a broad, flat plain known as the Canaseraga Valley, extends from Woodsville, New York downstream to the Genesee River. The valley is about 15 miles in length and varies from one to three miles in width. Canaseraga Creek meanders through the valley in a generally northwesterly direction. Keshequa and Bradner Creeks are two tributaries of Canaseraga Creek whose confluences are in the Canaseraga Valley.

51. The Canaseraga Valley, a rich agricultural area, is inundated to some extent annually by streamflow exceeding the channel capacity in the upper reaches of the valley and poor local drainage in the lower reaches. This poorly drained area provides habitat where thousands of waterfowl stop during their spring migration. Flood damages in the valley are agricultural consisting of crop and pastureland losses as well as other on farm losses such as fences and roads. The drainage problem in the lower reaches of the valley is the result of very flat gradients, the top of creek banks generally being higher in elevation than the surrounding farm lands, and limited waterway openings under road and railroad embankments of considerable height that traverse the valley. These conditions cause ponding from State Route 408 at Shakers Crossing upstream to West Sparta. The outline of the ponding area for the April 1961 flood, a 5-year event on an annual basis, is shown on Plates F-14 and F-15 of Appendix F. Inundation of this area has been

known to last for several months, as was the case after the 1961 flood. Ponding caused by spring floods prevents early planting thereby limiting the type of crops that can be grown because of the shorter growing season. Ponding as a result of summer flooding causes extensive damage because truck garden crops that have been planted are destroyed when inundated for an extended period.

52. Overland flooding, due to limited channel capacity, occurs in the upper reaches of the valley. Overbank flow on Canaseraga Creek occurs just downstream of Cumminsville at a flow of about 3000 cfs. The Dansville and Mount Morris Railroad embankment prevents the overbank flow from re-entering Canaseraga Creek further downstream and the high banks along Bradner Creek prevent the overbank flow from entering Bradner Creek. The result is flooding over the area west of the Dansville and Mount Morris Railroad for Canaseraga Creek discharges in excess of 3000 cfs. This is about a 1-year event on an annual basis and a 3-year event on a summer basis.

53. The Mount Morris flood control reservoir, a Federal project that went into operation in November 1951, has significantly reduced flooding in the lower reaches of the Canaseraga Valley from its confluence with the Genesee River upstream to Keshequa Creek. Prior to this project, high tailwater conditions on the Genesee River caused backup into the Canaseraga Valley and resulted in inundation of a portion of the lower valley.

54. The Canaseraga Project is described in survey scope detail in Part IV, Appendix C, Project Designs and Cost Estimates.

55. SOLUTIONS CONSIDERED

The flood problem in the area studied is agricultural in nature. Due to the drainage problem in the study area, any improvement contemplated must consider channel improvement in the study area to control local flows.

56. Reservoir control of flood waters originating in the Canaseraga Creek watershed was considered. Sites at Poag's Hole in Canaseraga Creek upstream of Dansville and downstream of Tuscarora, New York on Keshequa Creek were investigated. These sites could not provide the required protection when considered separately because of the small drainage area controlled by each. When considered jointly, the channel improvement would still be required in the study area of the Canaseraga Valley to obtain the desired protection. In any event, reservoir control was not considered justifiable for protection of the Canaseraga Valley flood area. Further discussion of the reservoir

sites can be found in Section III, Appendix 'C," Project Designs and Cost Estimates. The total investment cost is estimated for Poag's Hole reservoir at $32,100,000 and for Tuscarora reservoir at $17,000,000. Thus the total investment cost for the combined reservoirs would be $49,100,000 plus some cost for channel improvement.

57. Stream diversion, or similar types of remedial measures, was not considered feasible so was not given consideration during this study. Consequently, the study was concentrated on provision of protection in the immediate problem area utilizing channel improvement by straightening and enlargement, construction of levees and enlargement of waterway openings through bridges.

58. PROJECT PURPOSES

The proposed plan of improvement would provide for multi-purpose benefits from flood control and recreation. The flood control benefits would be agricultural consisting of benefits due to reduction of flood damages and changed land use and intensified land use benefits. The recreational benefits would be realized from fish and wildlife usage and would result from provision of ponding areas in the study area to be used as nesting and rearing grounds for waterfowl during the summer season and resting and feeding grounds during the fall migration. Additional recreational benefits would result from increased bird-watching opportunity and increased waterfowl hunting opportunity.

59. PLAN OF IMPROVEMENT

The plan of improvement was designed to:

a. Protect the Canaseraga Valley from Shakers Crossing upstream to White Bridge from flooding from the 5-year discharge on the "summer event" basis;

b. Sufficiently reduce the duration of flooding in the existing ponding area upstream of Keshequa Creek to assure the farmers use of this land by a certain date a certain percentage of the years; and

c. Provide a control at the lower end of the improvement to limit the discharge from the valley to that discharge that would have occurred under existing conditions and thereby produce no greater damage on the lower Genesee Basin due to discharge from Canaseraga Creek than would have occurred under existing conditions. The improvement was designed on the "summer events" basis since the major portion of the flood damages is the result of summer flooding and the related agricultural benefits from changed land use and more intensive land use results from acreage of crop land that would be protected against summer flooding.

60. DESIGN DETAILS

Details for the various structures incorporated in the plan of improvement are as follows:

a. Retention structure. The retention structure is approximately 12,600 feet in length and consists of:

(1). A gated concrete spillway and stilling basin, with separate gated outlet works, founded upon steel monotube piles.

(2). A 9000 ft. earth embankment non-overflow section, of 18 feet top width and 1 vertical on 2-1/2 horizontal side slopes, seeded and provided with a 12-ft. wide gravel roadway across the top for access and maintenance purposes.

(3). A 3500 ft. earth overflow section, of 18 feet top width and 1 vertical on 2-1/2 horizontal side slopes, seeded on the upstream slope, and riprapped across the top width and downstream slope. The riprap is a 3 ft. thickness of stone with a 2 ft. filter thickness.

b. Fish and wildlife ponds. The ponds are enclosed with an earth embankment, of ten feet top width, and 1 vertical on 2-1/2 horizontal side slopes, seeded. A small pumping station and gated conduits are incorporated into the embankment.

c. Control structures and weirs. The structures consist of Z-27 steel sheet piling driven across the channel bottom and into the side slopes. The upstream part is riprapped with an 18-inch thickness of stone upon a 6-inch filter bed. The downstream end is riprapped with a 2-ft. thickness of derrick stone.

d. New bridge. The two highway bridges are designed for a H-20 highway loading. The 22-ft. wide bridge deck is of steel grating supported on a steel beam superstructure erected on steel monotube pile bents. The three farm bridges are of similar design except the roadway width is reduced to 12 feet and the design loading is H-15.

61. METHOD OF OPERATION OF RETENTION STRUCTURE

The operation of the proposed retention structure would be a Federal responsibility. It would be operated in conjunction with Mount Morris Dam on the Genesee River. Stages in the retention reservoir would be telemetered to Mount Morris Dam and the spillway tainter gates operated from Mount Morris accordingly. The permanent fish and wildlife ponds within the proposed retention reservoir would be regulated by non-Federal interests. During the spring runoff period, the

runoff from the Canaseraga Creek Basin would be stored in the retention reservoir while discharging the maximum non-damaging flows from Mount Morris Dam. This method would result in providing the maximum available storage in the Mount Morris reservoir to provide control of future high runoff from the Upper Genesee Basin while using the stored volume in the retention reservoir on Canaseraga Creek to fill the Fish and Wildlife ponds upstream of the retention structure. In the event additional high flows to the retention reservoir on Canaseraga Creek would present the possibility of overtopping the 3500 foot overflow section and thereby losing control of the discharge from the retention reservoir, flow from Mount Morris Dam would be reduced to the required minimum of 300 cfs. in order that high non-damaging discharges could be released from the retention reservoir utilizing the spillway tainter gates. If the local flows in the Lower Genesee River Basin were high at this time, the discharge from the retention reservoir would be limited to flow that would have occurred under natural conditions. During summer storms, the outflow from Mount Morris Dam would be limited to the required minimum for a sufficient period of time to permit maximum non-damaging discharge from the retention structure on Canaseraga Creek. This would provide for minimum damage to the crop lands in the Canaseraga Valley.

62. LAND REQUIREMENTS

Lands for the retention structure embankment, levee embankment, channel improvement and the two permanent wildlife ponds would be required. Approximately 1400 acres of land would be required, 1140 acres of which would be required for the wildlife ponds.

63. GENERAL BENEFITS

Benefits would be realized from several sources for the multipurpose project proposed for the Canaseraga Valley. The estimated flood control benefits attributable to the project were provided by the Soil Conservation Service. The estimated fish and wildlife recreational benefits were provided by the U.S. Department of Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife.

64. Flood control benefits would result from the reduction of flood damages to agricultural lands by the lowering of Canaseraga Creek and tributary stages in the lower reaches of the Canaseraga Valley and protection by a levee in the upper reaches. Additional flood control benefits would be derived from changed land use and more intensive land use. The changed land use benefits would result from growing high value crops on land that is presently being used to grow lower valued crops because of the existing flood problem. The changed land use benefits are based upon the difference between the net annual

incomes derived from present crops and that derived from crops which farmers indicate they would grow if assured that flooding would be limited in frequency. Where land is potentially productive, as in the Canaseraga Valley, these benefits are substantial. Closely allied to changed land use benefits are more intensive land use benefits. These benefits are derived from shifting the land to a more intensified cropping system within the same general use plan. For example, additional inputs of capital in the form of fertilizers or land treatment might be justified on the unflooded land, causing increases in yield and profitability. The benefits are again equal to the increased net income due to the more intensive use.

65. Fish and wildlife benefits would result from provision of ponding areas to be used as resting and feeding areas for migratory waterfowl during the spring and fall migration and as nesting and rearing areas for continental waterfowl during the summer. Additional benefits that would be realized from the improvement are the recreational benefits from increased birdwatching opportunity and increased waterfowl hunting opportunity. An analysis of the increase in hunter demand in the Genesee Basin indicates that the number of hunter-days for all types of hunting can be expected to increase more than-threefold by the year 1990. Provided with the proposed permanent ponds, the number of waterfowl hunter-days attributable to the project can be expected to increase at least at the same rate. The project could be expected to provide at least the same increase in birdwatching opportunity.

66. ESTIMATED TOTAL FLOOD CONTROL BENEFITS

The estimated total average annual benefits for the reduction of flood losses, changed land use benefits and more intensive land use benefits are shown in table B-53 for the eight damage reaches of the Canaseraga Valley.

TABLE B-53. - Estimated total average annual benefits at long term adjusted normalized price levels.

Reach	Average annual benefits: Reduction of flood losses	Changed land use	More intensive land use	Totals
1	$ 16,120	$ 4,750	$ 25,210	$ 46,080
2	3,370	4,210	19,230	26,810
3	1,530	760	4,020	6,310
4	10,180	4,390	14,210	28,780
5	320	1,540	3,330	5,190
6	9,620	5,160	16,720	31,500
7	4,430	4,840	8,910	18,180
8	9,320	7,990	14,710	32,020
Total	$ 54,890	$ 33,640	$ 106,340	$ 194,870

67. FISH AND WILDLIFE HABITAT BENEFITS

The information presented was provided by the Fish and Wildlife Service of the U.S. Department of Interior in a Planning Aid Letter dated 15 June 1967 to be used for project planning purposes only and not to be used in lieu of an approved report.

68. Moderate fishery values in the lower reaches of the Canaseraga Valley are greatly outweighed by the waterfowl values that would be realized from the project. Therefore, it was considered that the latter should be conserved and developed even at the expense of some losses to the fisheries.

69. The poorly drained area from near State Route 408 upstream to Groveland, known locally as the Groveland Flats, has throughout the years provided habitat where thousands of migrating waterfowl have found a place to rest and feed. Primarily, this has been a stopping point on spring migration, due to the presence of ponding waters at that time. A relatively small amount of nesting has occurred; this has been limited, as has fall migration use, by the lack of ponded

waters in the summer and fall. Assuming that conditions continue to be about what they have been in the past, future use of the area is likely to remain at about the present level.

70. The average daily numbers of ducks and geese which presently use the area differ during periods of the year. In order to be able to draw comparisons with conditions which would exist with the project, this use has been related, insofar as possible, to the contemplated future pools.

71. The benefits presented are for conditions with the proposed improvement assuming that a Temporary Pond III would not be drained until 15 May each year, at which time most of the birds will have departed from the area and the few remaining could move over to one of the two permanent ponds. If Temporary Pond III were to be drained by 15 April, it was estimated that the ultimate waterfowl habitat value indicated would be cut in half.

72. Table B-54 presents the annual dollar value for habitat under ultimate conditions which would be realized about 20 years after completion of the project. The dollar values shown were determined by applying the minimum value of 12.4 cents per waterfowl-use day to the number of use-days.

73. During spring migration, the presence of thousands of waterfowl attracts people from as far away as Buffalo and Rochester. A survey by the New York State Division of Fish and Game in 1964 determined that at least 15,000 bird-watching days were enjoyed because of the birds at Groveland Flats that year. It is considered that this probably will be about the level of this type of use in the future without the project. Table B-55 presents the annual dollar value for bird-watching and waterfowl hunting with and without the project.

TABLE B-54 - Ultimate annual waterfowl use days and estimated habitat value in dollars (2)

Location	Spring Migration		Nesting & Rearing		Late Summer Use		Fall Migration		Total Use & Value	
	Waterfowl Days	Dollar Value (1)	Waterfowl Days	Dollar Value (1)	Waterfowl Days	Dollar Value (1)	Waterfowl Days	Dollar Value (1)	Waterfowl Days	Dollar Value
Pool I	313,000	$ 38,800	99,000	$12,300	12,600	$1,600	660,000	$ 81,800	1,084,600	$134,500
Pool II	180,000	22,300	50,100	6,200	6,300	800	480,000	59,500	716,400	88,800
Pool III	853,000	105,800	52,100	6,500	900	100	90,000	11,200	996,000	123,600
Total	1,346,000	$166,900	201,200	$25,000	19,800	$2,500	1,230,000	$152,500	2,797,000	$346,900

Table B-56

346,900
152,000
194,900

(1) All dollar values rounded to nearest $100.
(2) Ultimate use is expected to develop within 20 years after completion of the project.

TABLE B-55. - Summary of estimated annual birdwatching and waterfowl hunting values

Condition	Bird-watching: Use days	Bird-watching: Dollar (1) value	Waterfowl hunting: Use days	Waterfowl hunting: Dollar (2) value	Total $ value Birdwatching & hunting
With the project	45,000	$ 22,500	7,500	$ 30,000	$ 52,500 (3)
Without the project	15,000	7,500	2,500	10,000	17,500

$35,000

(1) Estimated at $0.50 per use day.
(2) Estimated at $4.00 per use day.
(3) Annual dollar value 20 years after completion of project = $52,500. It is expected that about 56, 84 and 96 percent of the 20-year value will have developed within 5, 10 and 15 years respectively, after completion of the project.

74. ESTIMATED TOTAL FISH AND WILDLIFE RECREATIONAL BENEFITS

The estimated total equivalent average annual fish and wildlife benefits attributable to waterfowl habitat and birdwatching and waterfowl hunting are shown in table B-56.

TABLE B-56. - Estimated total equivalent average annual fish and wildlife benefits

Average annual habitat benefits	$ 171,220
Average annual bird-watching and waterfowl hunting benefits	26,680
Total fish and wildlife benefits	$ 197,900

75. DISCUSSION

Comparison of the estimated total average annual flood control benefits of $194,870 shown in table B-53 with the estimated total average annual fish and wildlife recreational benefits of $197,900 shown in table B-56 shows that slightly more than 50 percent of the total project benefits would be provided by the fish and wildlife interests. Normally, a project could not be recommended if the general recreational benefits provide for 1/2 of the total project benefits. However, a large portion of the total fish and wildlife benefits would result from enhancement to migratory waterfowl. On the basis that the preservation and enhancement of migratory waterfowl would be of national significance, it was considered that this portion of the fish and wildlife benefits would not be classified as general recreational benefits and therefore should not be included when comparing the estimated total average annual fish and wildlife benefits to the total project benefits. Using this criterion, it was determined that the remaining general recreational benefits would provide for considerably less than 50 percent of the total project benefits. Since the total fish and wildlife benefits over flood control benefits would only be $3,030 ($197,900 - $194,870) it was considered that it would not be necessary to separate the benefits attributable to the migratory interests from the total fish and wildlife benefits.

76. PROJECT FORMULATION

A design discharge of 7,300 cfs. at Shakers Crossing was used to design the channels for the recommended plan of improvement. It has a frequency of recurrence of 5 years on the "summer events" basis. Allocation of costs for the improvement was made on the basis of benefits expected from flood control and fish and wildlife. The proposed dual-purpose project would have a benefit-cost ratio based on allocated costs of 1.2 to 1. A plan of improvement providing 10-year flood protection would result in a substantial increase in first costs and a minimal increase in flood control benefits indicating that further increments in the degree of flood protection would further decrease the above ratio. The fish and wildlife benefits, on which the above benefit-cost ratio is based, assumes that Temporary Pond III would not be drained prior to 15 May of each year. Earlier draining of this pond would decrease the above benefit-cost ratio.

77. ALLOCATION OF COSTS

Initial studies on Canaseraga Creek were directed toward development of plans to alleviate the flood problem. The flood control plan developed for protection of the Canaseraga Valley requires a retention structure to control the outflow from Canaseraga Creek into the Genesee River. This feature would be common to a fish and wildlife improvement by providing a controlled ponding area to be used by waterfowl. No changes in the plan of improvement for flood control would be required. However, certain features would be added to the improvement to obtain the recreational benefits from fish and wildlife. Sizable benefits would be realized from the use of the improvement by fish and wildlife interests. Studies were made to determine the amount of benefits that would result if the fish and wildlife use was developed with flood control in a dual-purpose project, and to determine the appropriate related allocation of project costs between the purposes.

78. Costs of the dual-purpose project were allocated first to each purpose, and then apportioned between Federal and non-Federal interests.

79. ESTIMATE OF COSTS AND BENEFITS FOR MULTIPLE-PURPOSE PROJECT

Table B-57 following, summarizes the estimated first costs, annual maintenance costs and annual benefits for a multiple-purpose project.

TABLE B-57. - Estimate of costs and benefits for multiple-purpose project

Construction costs:	
Lands	$ 236,000
Relocations	310,500
Channels	2,886,000
Levee	40,500
Retention structure	2,410,000
Fish and wildlife facilities	633,000
Engineering and design	580,000
Supervision and administration	370,000
Total	$ 7,466,000
Annual operations and maintenance costs:	$ 23,700
Annual benefits:	
Flood control	$ 194,870
Fish and wildlife	197,900
Total	$ 392,770

80. For allocation, flood control and fish and wildlife were considered the purposes of the project. Costs for project facilities needed to fully develop these two purposes were allocated to these purposes on the basis of separable costs and remaining benefits. All computations to determine annual charges for allocation of the first costs assumed an interest rate of 3-1/8 percent and a 50-years life. For all features, a two-year construction period was assumed, and interest for one year was added to first costs to determine investment costs. use 4 5/8%

81. Estimates of costs were developed for alternate projects which would produce single-purpose benefits equal to those produced by the dual-purpose project. The total estimated first and annual costs for alternative single-purposes flood control and fish and wildlife projects are given in table B-58. In the allocation, made on the basis of annual costs, the amount allocable to each purpose was limited by these alternate annual charges or by the related benefits, whichever were smaller. The single-purpose flood control project would not be justified, so allocation of the dual-purpose project costs to that purpose was limited by the flood control benefits developed.

TABLE B-58. - Annual charges for alternative single purpose projects

Item	Flood control	Fish and wildlife
First cost	$ 6,520,000	$ 3,740,000
Interest during construction	203,800	116,900
Investment	6,723,800	3,856,900
Annual charges:		
Interest	$ 210,120	$ 120,530
Amortization	57,420	32,940
Operation and maintenance	21,650	8,550
Total	$ 289,190	$ 162,020

82. Separable first costs and annual costs for each purpose were obtained by subtracting the costs of the alternate single-purpose plan from the costs of the dual-purpose project. The estimated separable first costs and separable annual costs for each purpose are given in table B-59.

TABLE B-59. - Annual charges for separable project costs

	Dual-purpose project			
	Separable costs			
	Flood control	Fish and wildlife	Joint use costs	Total
ESTIMATED COSTS	$	$	$	$
Construction expenditures	3,726,000(1)	946,000(2)	2,794,000	7,466,000
Interest during construction	116,400	29,600	87,300	233,300
Investment	3,842,400	975,600	2,881,300	7,699,300
Annual charges:				
Interest	120,080	30,490	90,040	240,610
Amortization	32,810	8,330	24,610	65,750
Operation and maintenance	15,150	2,050	6,500	23,700
Total	168,040	40,870	121,150	330,060

(1) Estimated first costs for single purpose fish and wildlife project = $3,740,000.

(2) Estimated first costs for single purpose flood control project = $6,520,000.

83. Annual costs of operation and maintenance of the dual-purpose project were estimated and allocated by the same method as the annual construction charges. The separable annual maintenance costs were assigned directly to their respective purposes. The remaining (joint) annual maintenance costs were then allocated on the basis of the benefits remaining after total separable annual costs were subtracted.

84. The allocated maintenance costs were subtracted from the allocated total annual costs, and the total first costs allocated to each purpose in proportion to the remainder. The allocation computations as described above are shown in table B-60.

TABLE B-60. - Allocation of costs to purposes

	Flood control	Fish and wildlife	Dual purpose
ALLOCATION COMPUTATION			
	$	$	$
First costs, alternate projects	6,520,000	3,740,000	7,466,000
Annual charges including operations and maintenance, alternate projects	289,190	162,020	330,060
Annual maintenance, alternative projects	21,650	8,550	23,700
Total annual benefits	194,870	197,900	392,770
Allocation of annual charges dual-purpose project:			
1. Benefits	194,870	197,900	
2. Alternative costs	289,190	162,020	
3. Benefits limited by alternative costs	194,870	162,020	
4. Separable costs	168,040	40,870	208,910
5. Remaining benefits	26,830	121,150	147,980
6. % distribution of item 5	18.13	81.87	100.00
7. Allocated joint costs	21,960	99,190	121,150
8. Total allocation	190,000	140,060	330,060
Allocation of maintenance, dual-purpose projects:			
9. Separable costs	15,150	2,050	17,200
10. % joint costs, item 6	18.13	81.87	100.00
11. Allocated joint costs	1,180	5,320	6,500
12. Total allocation	16,330	7,370	23,700
Allocation of first costs, dual-purpose project:			
13. Allocated annual charges	190,000	140,060	330,060
14. Allocated maintenance	16,330	7,370	23,700
15. Remainder	173,670	132,690	306,360
16. % distribution of item 15	56.69	43.31	100.00
17. Allocated first costs	4,232,500	3,233,500	7,466,000

85. APPORTIONMENT OF COSTS TO INTERESTS

The estimated apportionment of costs to interests for the dual-purpose project was based on the following criteria:

a. Flood control. The non-Federal share of the flood control costs would include the costs of lands, easements and rights-of-way, necessary relocations (excluding removal of three farm bridges) and the annual maintenance cost allocated to flood control less $150 for Federal inspections. On this basis, the non-Federal flood control costs would be $27,000 for lands, $309,000 for relocations and annual maintenance charges amounting to $16,180. The remaining flood control costs would be Federal.

b. Fish and wildlife. The non-Federal share of the fish and wildlife costs would include one-half of the separable costs chargeable to fish and wildlife and the annual operations and maintenance cost allocated to fish and wildlife less $50 for Federal inspections. Therefore, the non-Federal share of the fish and wildlife first costs of $946,000 would include separable costs of $473,000, including 50 percent of the land costs, and annual operations and maintenance costs would be $7,320. The remaining costs would be Federal.

86. Based on the allocation in table B-61, non-Federal interests would be allocated $809,000 of the $7,466,000 first costs for the development of the two project purposes. Of this amount, $440,000 represents costs of lands and relocations. The balance of the non-Federal responsibility, $369,000 may be met by a cash contribution toward Federal construction costs, construction of equivalent work or any suitable combination thereof.

87. The total estimated cost for operation and maintenance of the multiple-purpose project would be $23,700. In accordance with the allocation to project purposes, responsibility for maintenance costs would be divided between Federal and non-Federal interests as follows:

TABLE B-61. - Allocation of operations and maintenance costs

Item	Federal	Non-Federal(1)	Total
	$	$	$
Flood control	150	16,180	16,330
Fish and wildlife	50	7,320	7,370
Total	200	23,500	23,700

(1) Includes $2,500 for providing for operation of the retention structure which may be accomplished by federal interests.

88. The final breakdown of the first and annual costs for the two purposes of the dual-purpose project, the applicable benefits, and the benefit-cost ratio for each purpose and for the dual-purpose project, is shown in table B-62. All computations to determine annual charges assumed a Federal interest rate of 3-1/8 percent, a non-Federal interest rate of 3-1/8 percent and a 50-year project life. A two-year construction period was assumed for all features, and interest for one year was added to the first costs to determine the investment costs.

TABLE B-62. - Summarized allocation

Item	Flood control	Fish and wildlife	Total
	$	$	$
Allocated first costs			
Federal	3,896,500	2,760,500	6,657,000
Non-Federal	336,000	473,000	809,000
	4,232,500	3,233,500	7,466,000
Investment costs			
Federal	4,018,200	2,846,800	6,865,000
Non-Federal	346,500	487,800	834,300
	4,364,700	3,334,600	7,699,300
Annual Costs			
Interest & amortization			
Federal	159,890	113,280	273,170
Non-Federal	13,780	19,410	33,190
Maintenance	16,330	7,370	23,700
	190,000	140,060	330,060
Annual benefits	194,870	197,900	392,770
Benefit-cost ratio	1.03	1.4	1.2

CONCLUSION

89. A dual-purpose plan of improvement on Canaseraga Creek in the Canaseraga Valley from the mouth upstream to near Woodsville would be economically justifiable. The plan would consist of enlargement and straightening of approximately 20 miles of channels, provision of a retention structure with appurtenances near the downstream end of the study area and provision of fish and wildlife ponds upstream of the retention structure. This plan provides a feasible solution to the flood problem in the Canaseraga Valley and would produce sizable additional benefits attributable to fish and wildlife interests. Annual costs are estimated at $330,060 and annual benefits at $392,770. The ratio of benefits to cost would be 1.2 to 1.

GENESEE RIVER BASIN

COMPREHENSIVE STUDY OF WATER AND RELATED LAND RESOURCES

APPENDIX C - PROJECT DESIGNS AND COST ESTIMATES

PRELIMINARY DRAFT

GENESEE RIVER BASIN COMPREHENSIVE STUDY

APPENDIX "C"

SECTION IV - LOCAL PROTECTION PROJECTS

1. GENERAL

Reports have been completed for several local protection projects in the Genesee River Basin. The justified and recommended projects are: Red Creek in the towns of Brighton and Henrietta; Oatka Creek in the village of Warsaw; and the Genesee River, including Dyke Creek, in the village of Wellsville. The recommended plans of improvement for these projects are briefly discussed in paragraphs 57 through 59 of Appendix "F." As indicated in paragraph 62 of Appendix "F," a study for local protection at the confluence of Black Creek and the Genesee River in the town of Chili could not produce a justifiable improvement. Another local protection projection project being considered is Canaseraga Creek in Livingston County. Results of this study are discussed in the following paragraphs.

CANASERAGA CREEK LOCAL PROTECTION PROJECT

2. GENERAL

Canaseraga Creek is the largest tributary of the Genesee River with a drainage area of 335 square miles at the mouth. It is located in the Lower Genesee Basin and joins the Genesee River about 4 miles downstream of Mount Morris Dam. Streams tributary to Canaseraga Creek include Mill, Sugar and Slader Creeks and Stony Brook in the upper reaches of the basin and Keshequa and Bradner Creeks in the lower reaches. Keshequa Creek, with a drainage area of 76 square miles, is the largest stream tributary to Canaseraga Creek. The Canaseraga Basin, designated Subwatershed 13 for this comprehensive study, is shown on plate E1 of Appendix E.

3. The Canaseraga Creek Basin approximates a square of about 20 miles on a side. The upper reaches of the basin are steep and rugged with a main stem slope of about 40 feet per mile. The lower valley, from Dansville downstream to the confluence with the Genesee River, is a flat alluvial plain with a main stem slope of about 3 feet per mile. Plate E2 of Appendix E, a profile along the 42 miles of Canaseraga Creek, indicates the drastic change in topography between the upper and lower reaches of the basin. The creek, rising at about elevation 1900, joins the Genesee River at river mile 63 at about elevation 548.

4. DESCRIPTION OF THE PROBLEM AREA

The area studied, a broad, flat plain known as the Canaseraga Valley, extends from Woodsville, New York downstream to the Genesee River. The valley is about 15 miles in length and varies from one to three miles in width. Canaseraga Creek meanders through the valley in a generally northwesterly direction. Keshequa and Bradner Creeks are two tributaries of Canaseraga Creek whose confluences are in the Canaseraga Valley. The project location is shown on plate C1. The study area is shown on plate C2.

5. The Canaseraga Valley, a rich agricultural area, is inundated to some extent annually by streamflow exceeding the channel capacity in the upper reaches of the valley and poor local drainage in the lower reaches. This poorly drained area provides habitat where thousands of waterfowl stop during their spring migration. Flood damages in the valley are agricultural consisting of crop and pastureland losses as well as other on farm losses such as fences and roads. The drainage problem in the lower reaches of the valley is the result of very flat gradients, the top of creek banks generally being higher in elevation than the surrounding farm lands, and limited waterway openings under road and railroad embankments of considerable height that traverse the valley. These conditions cause ponding from State Route 408 at Shakers Crossing upstream to West Sparta. The outline of the ponding area for the April 1961 flood, a 5-year event on an annual basis, is shown on plates F14 and F15 of Appendix F. Inundation of this area has been known to last for several months, as was the case after the 1961 flood. Ponding caused by spring floods prevents early planting thereby limiting the type of crops that can be grown because of the shorter growing season. Ponding as a result of summer flooding causes extensive damage because truck garden crops that have been planted are destroyed when inundated for an extended period.

6. Overland flooding, due to limited channel capacity, occurs in the upper reaches of the valley. The area that was affected by overland flooding during the April 1961 flood is shown on plate F15. Overbank flow on Canaseraga Creek occurs just downstream of Cumminsville at a flow of about 3000 cfs. The Dansville and Mount Morris Railroad embankment prevents the overbank flow from re-entering Canaseraga Creek further downstream while the high banks along Bradner Creek prevent the overbank flow from entering Bradner Creek. The result is flooding over the area west of the Dansville and Mount Morris Railroad for Canaseraga Creek discharges in excess of 3000 cfs. This is about a 1-year event on an annual basis as shown on plate C12

and a 3-year event on a summer basis as can be seen from the discharge-frequency curves on plate C13. The summer event discharge frequency curves are discussed in paragraph C34. High discharges on Bradner Creek, in addition to high tailwater on Canaseraga Creek that affects the stage on Bradner Creek, contribute to the flooding of this area. Winter and spring overland flooding of the upper end of the valley would damage pastureland and nursery stock while flooding due to summer storms would also damage truck garden crops. However, the flood damage to the crops on a given acreage would not be as intensive as that occurring in the ponding area since the area would not be inundated for an extended period of time. Overland flooding from Canaseraga Creek also occurs in the area east of the Dansville and Mount Morris Railroad embankment and upstream of State Route 258 at Groveland Station. The high left bank of Canaseraga Creek downstream of the section where overbank flooding occurs prevents the overbank flow from returning to Canaseraga Creek. The overbank drainage is in the direction of the railroad embankment and the overland flow eventually enters the ponding area thereby contributing to the ponding problem.

7. EXISTING IMPROVEMENTS

The Mount Morris flood-control reservoir, a Federal project that went into operation in November 1951, has significantly reduced flooding in the lower reaches of the Canaseraga Valley from its confluence with the Genesee River upstream to Keshequa Creek. Prior to this project, high tailwater conditions on the Genesee River caused backup into the Canaseraga Valley and resulted in inundation of a portion of the lower valley.

8. A Federal clearing and snagging project on Canaseraga Creek from its mouth to Groveland Station was completed in 1954. This project improved conditions on and in the immediate vicinity of the main stem but the obstructed conditions on the tributary channels precluded any general reduction in either the scope or duration of flooding.

9. Local property owners have provided a realignment of about 5 1/2 miles of Canaseraga Creek from just downstream of Groveland Station upstream to near White Bridge to improve flow conditions in this reach. Another realignment project is in the vicinity of Keshequa Creek. It consists of 1 1/4 miles of channel. The State of New York constructed a canal in the area to the west of Bradner Creek to improve local drainage. The 4 miles of this canal, in addition to the other improvements discussed above, are shown on plate C10. A system of lateral ditches have been constructed throughout the valley by the local owners to improve the drainage from their farmlands.

10. PRIOR REPORTS

The survey report on the Genesee River, submitted to Congress 16 May 1944 and subsequently published in House Document No. 615, 78th Congress, 2nd Session, upon which authorization of the Mount Morris project was based, resulted in unfavorable recommendations of projects at certain points on Canaseraga Creek.

11. A report titled "Review of Report on Genesee River, New York, Vicinity of Dansville," dated 30 July 1945 and subsequently published in House Document No. 206, 80th Congress, 1st Session, produced an economically justified project. A project, consisting of channel improvement with a flood wall and levee system, was authorized as a result of this report.

12. The above authorized project was placed in an inactive status as per recommendation of the report titled "Report on Economic Studies for Design Memorandum on Local Flood Protection at Dansville and Vicinity, Canaseraga Creek, New York," submitted to OCE on 11 October 1956. It was determined at that time that the project could no longer be justified.

13. SOLUTIONS CONSIDERED

The flood problem in the area studied is agricultural in nature. Due to the drainage problem in the study area, any improvement contemplated must consider channel improvement in the study area to control local flows.

14. Reservoir control of flood waters originating in the Canaseraga Creek watershed was considered. Sites at Poag's Hole in Canaseraga Creek upstream of Dansville and downstream of Tuscarora, New York on Keshequa Creek were investigated. These sites could not provide the required protection when considered separately because of the small drainage area controlled by each. When considered jointly, channel improvement would still be required in the study area of the Canaseraga Valley to obtain the desired protection. In any event, reservoir control was not considered justifiable for protection of the Canaseraga Valley flood area. Further discussion of the reservoir sites can be found in Section III of this appendix.

15. Stream diversion, or similar types of remedial measures, was not considered feasible so was not given consideration during this study. Consequently, the study was concentrated on provision of protection in the immediate problem area utilizing channel improvement by straightening and enlargement, construction of levees and enlargement of waterway openings through bridges.

16. PROJECT PURPOSES

The proposed plan of improvement would provide for multi-purpose benefits from flood control and recreation. The flood control benefits would be agricultural consisting of benefits due to reduction of flood damages and changed land use and intensified land use benefits. The recreational benefits would be realized from fish and wildlife useage and would result from provision of ponding areas in the study area to be used as nesting and rearing grounds for waterfowl during the summer season and resting and feeding grounds during the fall migration. Additional recreational benefits would result from increased bird-watching opportunity and increased waterfowl hunting opportunity.

17. PLAN OF IMPROVEMENT

<u>Basis of Design</u> - The plan of improvement was designed to:

(1) Protect the Canaseraga Valley from Shakers Crossing upstream to White Bridge from flooding from the 5-year discharge on the "summer event" basis;

(2) Sufficiently reduce the duration of flooding in the existing ponding area upstream of Keshequa Creek to assure the farmers the use of this land by a certain date a certain percentage of the years; and

(3) Provide a control at the lower end of the improvement to limit the discharge from the valley to that discharge that would have occurred under existing conditions and thereby produce no greater damage on the lower Genesee Basin due to discharge from Canaseraga Creek than would have occurred under existing conditions. The improvement was designed on the "summer events" basis since the major portion of the flood damages is the result of summer flooding and the related agricultural benefits from changed land use and more intensive land use results from acreage of crop land that would be protected against summer flooding. Derivation of the "summer events"

discharge-frequency curves is discussed in paragraph 34 of this section and the discharge-frequency curves are shown on plates C13 and C14. The reduction in duration of flooding in the existing ponding area would result from the improvements made to provide for at least a 5-year protection in the study area. Features of the project plan are shown on plate C2.

18. Description of Improvement - The plan would include the following features:

(1) Enlargement and realignment of channels for approximately 15 miles along Canaseraga Creek, 4,050 feet along Keshequa Creek, 6,900 feet along Bradner Creek and 3,900 feet along the State Canal, a stream tributary to Bradner Creek.

(2) Replacement of 3 service bridges for farm vehicles, removal of 3 service bridges for farm vehicles, replacement of the Pioneer Road bridge over Bradner Creek and the Everman Road bridge over Canaseraga Creek.

(3) Construction of 6,700 linear feet of levee along the left bank of Canaseraga Creek upstream of White Bridge at the upstream limits of the improvement.

(4) Construction of sheet pile control structures on Canaseraga and Keshequa Creeks, 2 sheet pile weirs on Canaseraga Creek and a sheet pile weir on Bradner Creek.

(5) Construction of a retention structure across the valley downstream of Keshequa Creek. It would consist of an earth embankment 12,500 feet in length, a gated spillway to regulate flows from storms of the 100-year magnitude and a protected overflow section to pass flows from storms of the standard project storm magnitude without breaching the embankment. Material excavated from the channels would be used for the retention structure and levee embankments and for uncompacted fill in low areas adjacent to the channels.

(6) Provision of Fish and Wildlife ponds on the right and left banks of Canaseraga Creek in the area upstream of the confluence with Keshequa Creek. The ponds are shown on plate C10. Earth embankments, utilizing the material excavated from the channels, would provide for retention in the areas designated Permanent Pond I and Permanent Pond II. These ponds would be filled to the permanent pool elevations during the spring runoff period through gated conduits and the permanent pool elevations would be maintained through the summer months using pumps to replenish the losses due to evaporation and

seepage. Temporary Pond III would be formed during filling of the permanent ponds and would not require any structures. It would be drained utilizing the gated spillway every spring prior to 15 May to make the area available for planting.

19. Channel enlargement would generally follow alignments of existing channels except where bends could be corrected to provide more efficient flow conditions. The proposed channel realignments are shown on plate C2. The realignment of Canaseraga Creek from State Route 408 upstream to near the proposed retention structure provides a reduction in channel length of 7,800 feet. The proposed alignment for this area would not only provide a more efficient design, but would be more economical because of the friction losses in the addition 7,800 feet of channel that would have to be made up by lowering the thalweg, riprap required on the sharp bends on the existing alignment, the maintenance cost of the additional 7,800 feet of channel and enlargement of 7,800 feet of existing channel,

20. Improved channels would be trapazoidal with side slopes of 1 vertical on 2 1/2 horizontal. Plates C3 through C8 are profiles along Canaseraga, Keshequa and Bradner Creeks and the State Canal showing the improved thalweg, bottom widths, design water surface profiles and channel slopes. Because of the nature of the soils, the improved channels were designed to limit the velocities to 4.5 feet per second at design flows. Riprap protection would be provided upstream and downstream of bridges, control structures and weirs, and in the improved channels at locations where the velocity exceeded 4.5 feet per second at design discharge.

21. The proposed improvement would require bridge work at the locations shown on plate C2. Table C5 lists the bridges.

TABLE C5. - Bridges over Canaseraga Valley channels requiring improvement.

Bridge No.	Channel	Station	Description of Crossing
1	Canaseraga Creek	179+60	5-span farm bridge (1)
2	Canaseraga Creek	251+40	4-span farm bridge (2)
3	Canaseraga Creek	627+60	Farm bridge (2)
4	Canaseraga Creek	654+00	Farm bridge (1)
5	Canaseraga Creek	734+90	Farm bridge (2)
6	Canaseraga Creek	747+00	Farm bridge (1)
	Canaseraga Creek	694+50	2-span highway bridge at Everman Road (1)
	Bradner Creek	2+50B	2-span highway bridge at Pioneer Rd. (1)

(1) Replace existing structure.

(2) Remove existing structure.

22. The proposed levee on Canaseraga Creek upstream of White Bridge was designed to provide 2 feet of freeboard over the 10-year "summer events" stage. Overflow in this area causes most of the agricultural damages in the upper reaches of the valley and contributes to the ponding problem in the lower reaches of the valley. The direction of drainage behind the levee would be away from the creek, therefore internal drainage need not be considered.

23. Control structures and weirs would be constructed at several locations to reduce the quantity of excavation required for the improvement. A plan utilizing friction channels as an alternate to the control structures would produce a first cost comparable to that for the control structures but maintenance costs for the friction channels would be excessive. The location of the control structures and weirs are shown on plate C2 and are indicated on the profiles on plates C3 through C8.

24. A retention structure would be constructed downstream of the confluence of Keshequa Creek. This location, shown on plate C2, would provide control of flows into the Genesee River from the 76 square mile drainage area of Keshequa Creek in addition to controlling the Canaseraga Creek flows. An elevation along the axis of the structure, along with sections through the embankment, spillway and overflow section, is shown on plate C9. The purpose of the control structure would be to control the outflow from Canaseraga and Keshequa Creeks into the Genesee River. Uncontrolled flow from this area would produce damaging stages on the lower Genesee River at a recurrence interval of about once in 2 1/2 years on an annual events basis. Coincident discharge on the lower Genesee from local runoff would further increase the frequency of flooding on the lower Genesee. The storage capacity of the reservoir behind the structure would be sufficient to: limit the discharge into the Genesee River to a non-damaging discharge for storms of the 100-year magnitude on the Canaseraga Basin; and limit the discharge into the Genesee to that discharge that would have occurred under existing conditions for extensive storms that would produce high local discharges on the lower Genesee in addition to high flows on the Canaseraga. The reservoir conditions that would exist for the 100-year flood event, including the inflow hydrograph, spillway discharge hydrograph and reservoir stage, are shown on plate C9.

25. PAST FLOODS

The banks of Canaseraga Creek in the Canaseraga Valley are overflowed almost every year causing agricultural damage. Flooding of the area in the upper reaches of the basin from Cumminsville upstream is relatively infrequent due to the steep channel slopes and high banks. The flood of March 1913, for which records of discharge are not available, inundated the hamlet of Cumminsville to a depth of about 2 feet. For the storm of July 1940, producing the greatest discharge ever recorded at the U.S. Geological Survey gaging station at Dansville, the only significant damage reported in the upper reaches occurred on the property of the Foster Wheeler Corporation located in Cumminsville. Other storms have produced only minor damages in the upper reaches of the basin.

26. The large floods of record on the Genesee River Basin are listed and described in paragraph 16 of Appendix E. Effects of these floods on the Canaseraga Valley are discussed briefly. As indicated in paragraph 16, the floods of March 1865, June 1889, May 1894, April 1896, March 1902, July 1902, March 1913, May 1916, December 1927, July 1935, and April 1961 caused considerable inundation of the Canaseraga Valley. The storm of April 1961, producing peak discharges of 8,230 and 4,110 cfs at Dansville and Shakers Crossing respectively, caused extensive inundation and duration of flooding in the Canaseraga Valley. The isohyetal pattern of this storm as determined for the Genesee River Basin is shown on plate E11 of Appendix E. A detailed study of this storm was made for the Canaseraga Basin as it was the most severe storm on the basin for which discharge records at Dansville and Shakers Crossing were available. The flood hydrograph at Shakers Crossing for the April 1961 storm is shown on plate E17. Table E6 of Appendix E lists the recorded maximum discharges at the gage sites in the Canaseraga Basin.

27. UNIT HYDROGRAPHS

A synthetic inflow unit hydrograph was derived for the ponding area upstream of Shakers Crossing. Unit hydrographs derived for the areas upstream of the Dansville gage and Keshequa Creek at the mouth, in addition to unit hydrographs for two local areas upstream of Shakers Crossing were combined to produce the composite inflow unit hydrograph for the ponding area. The resulting inflow unit hydrograph was then routed through the ponding area to produce an outflow unit hydrograph for Shakers Crossing. The unit hydrograph at the Dansville gage was determined by averaging the unit hydrographs as determined from the discharge hydrographs at the gage for the March 1953,

April 1958 and April 1961 storms. Snyder's synthetic method was used to determine the unit hydrograph on Keshequa Creek at Sonyea. The Taylor-Schwarz method, described in paragraph 16A of the Detailed Hydrology Attachment of Appendix E, was used to determine the synthetic unit hydrographs for the two local areas. The inflow unit hydrograph to the ponding area was tested by applying the rainfall excess from the April 1961 storm to the unit hydrograph and routing the resulting storm hydrograph through the ponding area. The routed outflow hydrograph was in agreement with the recorded hydrograph at the Shakers Crossing gage for the April 1961 storm. The 6-hour inflow and outflow unit hydrographs at Shakers Crossing are shown on plate C11.

28. The inflow unit hydrograph at Shakers Crossing was used to: (1) Establish flows into the ponding area upstream of Shakers Crossing as a basis for the design of the retention structure; (2) Establish flows into the ponding area as a basis for the determination of stage-frequency relationships for the reaches in the ponding area; and (3) Establish flood discharges within the Canaseraga Creek Basin due to the standard project flood.

29. STANDARD PROJECT FLOOD

A standard project flood estimate for the Canaseraga Creek basin was prepared in accordance with paragraph 1-69 of EM 1120-2-101 and Civil Works Engineer Bulletin No. 52-8, ENGWE dated 26 March 1952, reprinted June 1964, and was forwarded by letter dated 9 February 1967 through NCD to Office, Chief of Engineers and approved by OCE by 2nd Indorsement on 5 April 1967.

30. The standard project flood determination was done using Corps of Engineers computer program 23-J2-J228, "Unit Graph and Hydrograph Computations," prepared by the Hydrologic Engineering Center, Sacramento. This program computes the standard project storm and standard project flood in accordance with Bulletin 52-8. The standard storm pattern of Bulletin 52-8 was oriented to give the greatest concentration of rainfall over the Canaseraga Creek Basin. It was determined that this orientation would cause more severe flooding in the basin than if oriented to give the greater concentration of rainfall over the entire Genesee River Basin.

31. Neither levee heights nor channel capacities were designed to provide protection against the standard project flood. However, the proposed retention structure upstream of Shakers Crossing was designed to pass the standard project flood flows without breaching the embankment. Using criteria established in Engineer Circular 1110-2-27 titled "Policies and Procedures

Pertaining to Determination of Spillway Capacities and Freeboard Allowances for Dams," dated 1 August 1966 and a paper in the Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers titled "Hydrology of Spillway Design; Large Structures-Adequate Data," by Franklin F. Snyder and dated May 1964, it was considered that the standard project flood would be adequate as the Spillway Design Flood for the proposed retention reservoir. In the basic letter of 9 February 1967 to O.C.E., it was requested that the standard project flood for Canaseraga Creek at Shakers Crossing be approved as the Spillway Design Flood for the proposed retention structure. In reply by 2nd Indorsement, O.C.E. stated that based on the information presented the standard project flood was considered appropriate for use as the Spillway Design Flood for the retention structure provided that results of detailed design and economic studies support the selection. The peak inflow to the ponding area for the standard project flood was determined to be 126,000 cfs. Under existing conditions, storage in the valley would reduce the peak discharge to about 90,000 cfs and the proposed retention structure would further reduce the peak discharge to about 88,000 cfs.

32. DISCHARGE-FREQUENCY FOR CANASERAGA CREEK

Discharge-frequency curves were determined on an "annual events" and a "summer events" (May through October) basis. Separate curves were developed for several reasons. First, determination of floodwater damages under existing conditions necessitated use of the "annual events" discharge-frequency curves. Determination of these damages on a less severe basis would have resulted in average annual values considerably less than are occurring in the area. Second, "annual events" curves were required to determine storage requirements for the reservoir behind the proposed retention structure. The "summer events" discharge-frequency curves would be required to determine the benefits attributable to the Changed Land and Intensified Land Uses that are discussed in paragraphs 71 through 73. Since the damages in the study area are agricultural, with most of the damages the result of summer flooding of the croplands, discharges based on the "summer events" frequency were used to design the improved channels.

33. The "annual events" discharge-frequency curves for several locations in the Canaseraga Basin are shown on plate C12. Several methods were used to determine the frequency curves for these locations. Beard's analytical method for the 50 years of record at the gage was used to determine the frequency curve near Dansville. In the absence of an extended period of stage

or discharge records on Keshequa Creek, a Beard-type statistical study of seven Western New York gaging-stations with characteristics similar to the Keshequa Creek Basin was used to determine discharge-frequency relationships for Keshequa Creek at Sonyea. This method was also used for the inflow-frequency curve for Shakers Crossing, but the resulting curve was adjusted to reflect the reduction in lag time of the sub-area contributions due to storage in the Canaseraga Valley. The adjustment would account for the curve not being a straight line. The frequency curve for the outflow from Shakers Crossing was determined by routing the inflow flood volumes for various events through the storage area upstream of Shakers Crossing. The resulting outflow curve shown on plate C12 compared reasonably well with a curve determined for six years of record through 1964 at Shakers Crossing and adjusted by a correlation using the Dansville record.

34. The "summer events" (May through October) discharge-frequency curve for Dansville was determined using Beard's Plotting Position Method for peak discharges at Dansville for the period of record. To determine the "summer events" frequency curves for other desired areas in the Canaseraga Basin, a relationship based on drainage area was determined. Using a comparison of the total flows at Dansville and Shakers Crossing for three years of record, the relationship, $Q_{sc}/Q_d=(D.A._{sc}/D.A._d)^{0.77}$ where Q_{sc} is the discharge at Shakers Crossing, Q_d is the discharge at Dansville, $D.A._{sc}$ is the drainage area in sq. mi. at Shakers Crossing and $D.A._d$ is the drainage area in sq. mi. at Dansville, was determined. It was assumed that the above equation was applicable to other sub-areas of Canaseraga Creek and its tributaries at locations where frequency curves were desired and therefore frequency curves for these sub-areas were determined using this equation. The curves for several locations in the Canaseraga Basin are shown on plates C13 and C14.

35. STAGE-AREA INUNDATED CURVES FOR CANASERAGA VALLEY

Stage-area curves for the damage reaches shown on plate C15 were required to evaluate the agricultural benefits attributable to the proposed improvement. The stage-area curves for the damage reaches are shown on plate C16. Individual curves for existing and improved conditions in the ponding area reaches 2, 3 and 4 were required since under existing conditions the water surface in the ponding area is sloped while for improved conditions the water surface would nearly be horizontal due to the increased efficiency of the improved channels.

36. Flood profiles for several floods in the lower valley where ponding occurs provided the basic information from which the stage-area curves under existing conditions for reaches 1 through 4 and 6 were determined. For a given stage at the location of the proposed retention structure (Station 223+00 on Canaseraga Creek), the corresponding stages at other locations in the ponding area were plotted on cross sections at the various locations. The width of valley flooded at the various cross sections for the given stage at the retention structure were then determined from the cross sections. Multiplying the average width flooded between two adjacent cross sections by the distance between the cross sections determined the area flooded between the cross sections for the given stage at the retention structure. Addition of the flooded area between cross sections for all the sections in the ponding area produced the total flooded area for a given stage at the retention structure. Repetition of this process for several stages at the retention structure provided sufficient data to determine the stage-area relationship for reaches 1 through 4 and 6.

37. The stage-area relationships for improved conditions for reaches 2, 3, 4, and 6 (the reaches in the retention reservoir) were determined by the same method as explained above. However, because of the assumed level pool for improved conditions, the stage at any cross section would be the same as the stage at the retention structure, thereby simplifying the calculations considerably.

38. Referring to plate C15, "Damage Reaches," reaches 5, 7, and 8 are flooded by overland flow. In order to obtain the stage-area curves for these reaches, backwater computations were made on Canaseraga Creek to obtain overbank discharges for several frequencies. Using an estimated velocity of flow in the overbank and the previously determined overbank discharge, the cross-sectional area of flow in the overbank was determined, or $A=Q/V$, where A is cross-sectional area in sq. ft., Q is the overbank discharge in cfs, and V is the estimated overbank velocity of flow in feet per second. The stage at any desired location in the overbank could then be determined by relating the required cross-sectional area of flow to the actual cross section at the same location. The stage for a given frequency was determined at a sufficient number of locations in the overbank reaches to draw water surface profiles for the reaches. After determining the overbank water surface profiles for several frequencies the stage-area curves could then be obtained by the same method used for the sloping water surface in the ponding area.

39. STAGE-FREQUENCY FOR CANASERAGA VALLEY

Stage-frequency curves for the index points of the damage reaches shown on plate C15 were determined on the "summer events" and "annual" basis for existing conditions and on the "summer events" basis for improved conditions. The stage-frequency curves for the damage reaches for the above conditions are shown on plate C17.

40. For the reaches in the ponding area (reaches 1 through 4 and 6), a routing procedure was required to obtain the stage-frequency curves because of the storage effects of the pond. Routing of the inflow hydrograph for a given event through the ponds produced the maximum stage for the same event at the proposed retention structure. Stages at the various index points for the same event were then obtained using the water surface profile previously discussed in the stage-area section. Hydrographs for several events were routed through the ponding area to enable drawing of the stage-frequency curves.

41. AREA INUNDATED-FREQUENCY CURVES FOR CANASERAGA VALLEY

The stage-area curve for each reach was used with the relevant stage-frequency curve to obtain the area-inundated-frequency relationship for that reach. The resulting area inundated-frequency curves to be used to determine the agricultural benefits are shown on plate C18.

42. VOLUME-FREQUENCY CURVES

Volume-frequency determinations for the inflow volumes to the ponding area upstream of Shakers Crossing were made for various durations to determine the critical duration for design of the proposed retention structure. Routing of the inflow volumes through the retention reservoir determined the critical duration for any event to be approximately two days. For durations in excess of two days, the capacity of the retention structure spillway and the channel downstream would be sufficient to discharge a greater volume than the inflow volumes. The inflow volume-frequency curves for the maximum runoff of 1, 3, 7, 15, 60 and 90 consecutive days are shown on plate C9.

43. The inflow volume-frequency curves shown on plate C9 were determined using the 43 years of record through 1960 for the Dansville gage. The highest mean discharge for the above mentioned number of consecutive days for each year for the period of record was provided by the Department of Interior, Geological Survey-Water Resources Division. A beard-type

statistical analysis was used to determine the frequency curve for any particular duration of flow at Dansville. This determination was done by electronic computer using a program prepared by the Buffalo District. The flow-duration-frequency curves for the ponding area were then determined from the results for the Dansville gage using the drainage area relationship, $Q_{sc}=Q\ (D.A._{sc}/D.A._{d})^{0.77}$, previously discussed in paragraph 34. These flow-durations were then converted to volume-durations to produce the desired inflow-volume-frequency curves for the ponding area.

44. A comparison was made of the volume for several frequencies as determined above with the volume resulting from application of rainfall, for the same frequencies, to the unit hydrograph at Shakers Crossing. The volumes compared reasonably well, although the volumes determined using rainfall applied to the unit hydrograph were slightly higher. The volume-frequency curves were adjusted to reflect the results determined from applying rainfall to the unit graph since this condition would be more conservative.

45. HYDRAULIC DESIGN-CHANNELS

The design discharge for the considered plan of improvement was selected to provide the highest degree of protection based on the following considerations:

(1) 5-year "summer events" peak discharge;

(2) Provision of an adequate degree of protection for the type of damages sustained in the flooded area;

(3) Maximum allowable non-damaging discharge into the Genesee River;

(4) Channels resulting from the selected design discharge that are large enough and efficient enough to drain the ponding area in a designated time period;

(5) Consideration of maximization of benefits from improvements. A discharge of 7,300 cfs was adopted as the design discharge for the considered channel improvement. It has a frequency of occurrence of 5 years on a "summer events" basis, and an exceedence interval of about 1.4 years on an "annual" basis. A channel design providing protection against the 10-year summer event was investigated. The study showed that the most favorable benefits over cost ratio occurred at a discharge of 7,300 cfs. The design discharge on Canaseraga Creek was reduced in the upstream direction because of the

reduction in drainage area. It was determined that the critical design stages on the tributaries would occur with high stages on the Canaseraga and relatively low flows on the tributaries rather than at low stages on Canaseraga with high flows on the tributaries. The design discharge for the various reaches of channel is listed in table C6.

TABLE C6 - Design discharges along Canaseraga Creek and its Tributaries (1)

	Improved Channel Stationing From	To	Discharge (cfs)
Canaseraga Creek	-10+00	139+00	7,300
Canaseraga Creek	139+00	374+00	5,800
Canaseraga Creek	374+00	800+00	5,000
Keshequa Creek	0+00K	40+00K	1,500
Bradner Creek	0+00B	38+00B	800
Bradner Creek	38+00B	69+00B	400
State Canal	0+00C	39+00C	400

(1) 5-year "summer event" discharge on Canaseraga Creek.

46. Genesee River discharges at the mouth of Canaseraga Creek are controlled by operation of the Mount Morris Dam. For the channel design in the study area, it was assumed that the flow from Mount Morris Dam could be limited to 300 cfs, the required minimum when the inflow to the reservoir is in excess of this value. The design discharge of 7,300 cfs on Canaseraga Creek, in addition to the assumed 300 cfs from Mount Morris Dam, was backwatered up the Genesee River from Jones Bridge to the confluence of Canaseraga Creek to determine the tailwater elevation at the confluence.

47. Channel dimensions and grades to produce non-damaging stages at the design discharge were established by backwater computations made in accordance with instructions contained in EM 1110-2-1409 dated 7 December 1959, entitled, "Engineering and Design-Backwater Curves in River Channels." The backwater computations were made by "Method 1" in Appendix III of the above reference. Losses through bridges were computed by the formula $Q=KA\ (2gh+V)^{0.5}$ where K=contraction coefficient and varied depending on the relative constriction, A=net area of the bridge based on the downstream water surface elevation, h=differential head from upstream to downstream and V=the average velocity of approach. Where the plan would require new bridges, waterway openings were provided which would give the same flow area as the adjacent upstream channel at design flow conditions.

48. The improved channel sections were designed with a trapezoidal cross-section having sideslopes of 1 vertical on 2-1/2 horizontal. The improved channel would have vegetal protected side slopes except in reaches where high velocities would require riprap protection.

49. Water surface profiles for improved conditions were determined by the step solution of Manning's formula beginning at the U.S. Geological Survey gage at Jones bridge on the Genesee River where the water surface was known, and computing the water surface elevation at the next adjacent cross-section. This step solution was carried on through the entire reach of the project in the same manner as described above until the entire water surface profile was established for the design discharge for improved conditions. Water surface profiles for the design discharges for improved conditions are shown on plates C3 through C8. A Manning's "n" value of 0.030 was used for the improved, grass protected channels. Transition losses were taken as 0.2 and 0.4 of the difference in velocity heads between successive cross-sections for contractions and expansions, respectively. The average velocity throughout the improved reaches was kept below the maximum of 4.5 feet per second determined allowable for the type of soil in the study

area. The U.S. Department of Agriculture, Soil Conservation Service publication titled "Handbook of Channel Design for Soil and Water Conservation," dated March 1947, revised June 1954, was used to determine the type of vegetal cover to be used and channel velocities allowed for the given soil conditions.

50. Protection for the design discharge would require construction of a levee at the upstream limits of the study area. The levee would provide two feet of freeboard above the 10-year water surface profile and would range from 1 to 3 feet in height, including freeboard allowances. Except where riprap protection is proposed, seeding would be required on top of the levee and on both slopes.

51. HYDRAULIC DESIGN - RETENTION STRUCTURE

The retention structure would consist of an earth embankment with a spillway section and a protected overflow section. Details for the retention structure are shown on plate C9. The spillway section would consist of a low concrete sill with a vertical upstream face. The downstream face would be defined by the equation $X^2=40Y$, the considered optimum shape determined by model study for the low-head navigation dams on the Arkansas River and presented in Technical Report No. 2-655, September 1964 by the U.S. Army Engineer Waterways Experiment Station. The spillway section would consist of two 37.5-foot bays with one 10-foot wide center pier. Flow would be controlled by two tainter gates, each 37.5 feet long and 23.5 feet high. The spillway crest would be at elevation 549.0 with the top of the gates at elevation 572.5. A pool elevation of 555.0 would be maintained by locating the upstream invert of the outlet works at elevation 555.0 so that the water table upstream of the structure would be comparable to that under existing conditions. A spillway rating curve was computed for a net crest length of 75 feet. The basic discharge equation for submerged uncontrolled flow presented in T.R. 2-655, $Q=C_sLH\,(2g\,H_d)^{0.5}$ where, Q is the discharge in cfs, C_s is the discharge coefficient, L is the net length of spillway crest in feet, H is the tailwater elevation referred to weir crest in feet and H_d is the differential between total energy of the approach channel and depth of tailwater referred to the crest in feet, was used to determine the spillway rating curve. The discharge coefficient, C_s, was taken from plate 41 of T.R. 2-655.

52. The standard project flood (S.P.F.) was used as the basis of design for the protected overflow section. For the S.P.F., the crest velocity was limited to 8 feet per second. To adhere to the velocity requirements and the maximum allowable topography

requirements for the area, a length of overflow section of 3,500 feet would be required. The crest elevation would be 572.5 and the crest would have riprap protection. The maximum head on the crest would be 3.3 feet, the head differential between upper pool and tailwater would be 2.8 feet at maximum discharge and the maximum discharge over the overflow section would be about 59,000 cfs. The slope of the downstream face of the overflow section would be 1 vertical on 2-1/2 horizontal and would be riprapped from the crest to the toe of slope. The thickness of riprap would be 3 feet and 2 feet of filter blanket would be provided. Velocities on the downstream slope would vary from 12 fps at minimum tailwater conditions and an overflow section discharge of 17,000 cfs to approximately 20 fps at the maximum discharge would provide for dissipation of the velocity head at approximately a third of the distance down the downstream slope. Therefore it was considered that riprap protection would not be required for any appreciable distance downstream of the toe of slope.

53. The stilling basin for the gated section was designed in accordance with hydraulic design criteria established in the Bureau of Reclamation Engineering Monograph No. 25 entitled "Hydraulic Design of Stilling Basins and Energy Dissipators," dated 1964. The maximum spillway design flood pool elevation, with the corresponding maximum discharge, was used to determine the D_1 and D_2 depths. The stilling basin would be 85 feet wide and 100 feet long with its surface at elevation 547.6. Due to the submergence effect caused by high tailwater conditions, it was determined that an end sill would not be required. 17

54. The outlet works was designed to discharge 1000 cfs at an upper pool elevation of 564.0. This elevation would be 2 feet below the damaging stage in the area upstream of the retention structure. This criteria would provide for a minimum of operation of the spillway tainter gates during the summer months so as to prevent flooding of the croplands upstream of the retention structure. A duration study of daily summer flows at Dansville for 29 years of record, adjusted to Shakers Crossing, indicated that a flow of 1000 cfs on a daily basis could be expected to be exceeded about 1/2 of 1 percent of the time or about 1 day a year on the summer basis. The upstream invert elevation of the outlet works would be 555.0, the elevation required to prevent drawdown of the watertable below that under existing conditions. Slide gates would be provided. Table C7 is a summary of the hydraulic design data for proposed retention structure and appurtenances.

TABLE C7. - Hydraulic design data - Retention Structure

Top of embankment - elevation	580
Maximum spillway design flood (S.P.F.) elevation	576
Channel elevation at heel of dam	546.9
Channel elevation at toe of dam	547.6
Gated spillway data	
Type of gate sill	Broad-crested weir (1)
Effective spillway length-feet	75
Crest elevation	549.0
Top of gates-elevation (elev. at which flow over the overflow section begins)	572.5
Overflow section data	
Length-feet	3,500
Crest elevation	572.5
Downstream slope	IV:2-1/2H
Riprap, downstream slope - thickness in feet	3
Filter blanket, downstream slope - thickness in feet	2
Stilling basin data	
Type	I(2)
Length - feet	100
Elevation	547.6
End sill	None

(TABLE C7. con't. - Hydraulic design data - Retention Structure)

Outlet works data	
Invert elevation at intake	555.0
Invert elevation at toe of dam	547.6
Area - sq. ft.	68
Tailwater Elevations	
Spillway design flood (S.P.F.)	573.5
Average flow (270 CFS)	549

(1) See plate 3, T.R. No. 2-655, "Spillway for Typical Low-Head Navigation Dams, Arkansas River, Arkansas."

(2) See Engineering Monograph No. 25, "Hydraulic Design of Stilling Basins and Energy Dissipators," dated 1964 by the Bureau of Reclamation.

55. DESIGN DETAILS

Details for the various structures incorporated in the plan of improvement are as follows:

a. Retention Structure - The retention structure is approximately 12,600 feet in length and consist of:

(1). A gated concrete spillway and stilling basin, with separate gated outlet works, founded upon steel monotube piles.

(2). A 9000 ft. earth embankment non-overflow section, of 18 feet top width and 1 vertical on 2-1/2 horizontal side slopes, seeded and provided with a 12-ft. wide gravel roadway across the top for access and maintenance purposes.

(3). A 3500 ft. earth overflow section, of 18 feet top width and 1 vertical on 2-1/2 horizontal side slopes, seeded on the upstream slope, and riprapped across the top width and downstream slope. The riprap is a 3 ft. thickness of stone with a 2 ft. filter thickness.

b. Fish and Wildlife Ponds - The ponds are enclosed with an earth embankment, of ten feet top width, and 1 vertical on 2-1/2 horizontal side slopes, seeded. A small pumping station and gated conduits are incorporated into the embankment.

c. Control Structures and Weirs - The structures consist of Z-27 steel sheet piling driven across the channel bottom and into the side slopes. The upstream part is riprapped with an 18-inch thickness of stone upon a 6-inch filter bed. The downstream end is riprapped with a 2-ft. thickness of derrick stone.

d. New Bridge - The two highway bridges are designed for a H-20 highway loading. The 22-ft. wide bridge deck is of steel grating supported on a steel beam superstructure erected on steel monotube pile bents. The three farm bridges are of similar design except the roadway width is reduced to 12 feet and the design loading is H-15.

56. METHOD OF OPERATION OF RETENTION STRUCTURE

The operation of the proposed retention structure would be a federal responsibility. It would be operated in conjunction with Mount Morris Dam on the Genesee River. Stages in the retention reservoir would be telemetered to Mount Morris Dam and the spillway tainter gates operated from Mount Morris accordingly. The permanent fish and wildlife ponds within the proposed

retention reservoir would be regulated by non-Federal interests. During the spring runoff period, the runoff from the Canaseraga Creek Basin would be stored in the retention reservoir while discharging the maximum non-damaging flows from Mount Morris Dam. This method would result in providing the maximum available storage in the Mount Morris reservoir to provide control of future high runoff from the Upper Genesee Basin while using the stored volume in the retention reservoir on Canaseraga Creek to fill the Fish and Wildlife ponds upstream of the retention structure. In the event additional high flows to the retention reservoir on Canaseraga Creek would present the possibility of overtopping the 3500 foot overflow section and thereby losing control of the discharge from the retention reservoir, flow from Mount Morris Dam would be reduced to the required minimum of 300 cfs in order that high non-damaging discharges could be released from the retention reservoir utilizing the spillway tainter gates. If the local flows in the Lower Genesee River Basin were high at this time, the discharge from the retention reservoir would be limited to the flow that would have occurred under natural conditions. During summer storms, the outflow from Mount Morris Dam would be limited to the required minimum for a sufficient period of time to permit maximum non-damaging discharge from the retention structure on Canaseraga Creek. This would provide for minimum damage to the croplands in the Canaseraga Valley.

57. FOUNDATION CONDITIONS AT PROPOSED RETENTION STRUCTURE SITE

The site is downstream of the confluence of Keshequa Creek with Canaseraga Creek on the floor of a practically level valley, the average width of which is approximately 2 miles. Two relatively shallow borings were made in the valley close to the proposed damsite, penetrating about 32 feet of foundation material. The approximate location of the explorations are shown on plate C2 and the plotted logs of the borings appear on plate C9. The soils within this depth are very fine-grained and impervious, consisting mainly of medium or firm lean clays and silty clays. It is reported that a well-boring, drilled about 3 miles north of Dansville, New York, penetrated 450 feet without reaching bedrock. Hence, it will be necessary to found concrete structures (spillway, etc.) on piles.

58. SOURCES OF CONSTRUCTION MATERIALS

Impervious soils are available in the valley for construction of the rolled embankments of the retention structure, wildlife ponds and levees. The material excavated from the channels would be used for the embankments. Stone for riprap and materials for concrete aggregate and bedding are available within a 20-mile radius of the project.

59. RELOCATIONS

The plan of improvement requires replacement of farm bridges 1, 4 and 6, Everman Road bridge over Canaseraga Creek and Pioneer Road bridge over Bradner Creek. Farm bridges 2, 3 and 5 would be removed. The locations of these structures are shown on plate C2. Underground communication cables, water lines or gas lines located within the limits of the permanent wildlife ponds upstream of the retention structure would be relocated.

60. LAND REQUIREMENTS

Lands for the retention structure embankment, levee embankment, channel improvement and the two permanent wildlife ponds would be required. Approximately 1400 acres of land would be required, 1140 acres of which would be required for the wildlife ponds.

61. DAMAGE REACHES.

The locations of index points and the limits of damage reaches are shown on plate C15. Brief descriptions of the damage reaches and index points are given in table C8. Eight damage reaches were selected so that the area in each reach would be subject to flooding from the same source to approximately the same stage, so that the effects of higher or lower discharges would be uniform throughout the reach. The limits were also set, considering anticipated improvements, so that the index points within these reaches would be representative of both existing and improved conditions.

TABLE C8. - Damage reaches

Reach Number	Location of Index Point	Initial Damaging Stage Feet	Description of reach
1	On Canaseraga Creek 1600 feet downstream of the confluence with Keshequa Creek	560.0	An irregular shaped area with the downstream limit at State Route 408 and the upstream limit at the proposed retention structure at station 223+00.
2	On Canaseraga Creek 1400 feet downstream of the confluence with Keshequa Creek	560.0	A triangular shaped area bounded on the west by the Erie-Lackawana R.R. embankment, on the east by State Route 63 and on the south by the proposed retention structure at station 223+00.
3	100 feet downstream of Pioneer Road and 1500 feet east of State Route 36	568.0	A trapezoidal area bounded on the east by the Erie-Lackawanna R.R., on the north by Keshequa Creek and on the south by Pioneer Road.
4	100 feet downstream of State Route 258 on State Canal	566.0	A trapezoidal area bounded on the east by the Erie-Lackawanna R.R., on the north by Pioneer Road and on the south by State Route 258.
5	On Canaseraga Creek approximately 3500 feet north of Everman Road bridge and 50 feet upstream of an existing farm bridge	583.8	The area to the east of the Dansville and Mount Morris R.R. from State Route 258 upstream to White bridge.

TABLE C8. - Damage reaches (cont'd

Reach Number	Location of Index Point	Initial Damaging Stage Feet	Description of reach
6	100 feet upstream of State Route 258 on State Canal	566.0	A trapezoidal area bounded on the east by the D.&M Mo.R.R., on the north by State Route 258 and on the south by a line perpendicular to the railroad 9100 feet south of the junction of State Route 258 and the railroad.
7	7200 feet downstream of Everman Road on State Canal	568.0	The area to the west of the D.&M.Mo. R.R., bounded on the north by the southern limit of reach 6 and on the south by Everman Road.
8	On Bradner Creek 100 feet upstream of Everman Road	582.8	The area to the west of the D.&M.Mo.R.R., bounded on the north by Everman Road and on the south by the right bank of Canaseraga Creek.

DAMAGES

62. GENERAL

The study to determine the flood damages and the flood control benefits attributable to the proposed improvement was a joint endeavor undertaken by the Corps of Engineers and the Soil Conservation Service of the U.S. Department of Agriculture. Damage surveys were made by the Corps of Engineers. The area inundated-frequency curves that were required to obtain the average annual flood damages and benefits were determined by the Corps of Engineers. Combining this information with additional data collected, the Soil Conservation Service determined the damages under existing conditions and the flood control benefits.

63. DAMAGE SURVEY

Damage surveys were made in the Canaseraga Valley in November 1961 and January 1962 to obtain flood damages resulting from the April 1961 flood. Personnel of the Soil Conservation Service of the U.S. Department of Agriculture assisted in the surveys since they were familiar with the problem area and the landowners in the area. Interviews were conducted with 18 landowners and provided data on approximately 45 percent of the cropland acreage flooded during the April 1961 flood. Local officials provided information as to damages sustained to public facilities during the April 1961 flood.

64. METHOD OF ESTIMATING FLOOD DAMAGE

The data collected for the April 1961 flood, combined with additional information obtained from members of the agricultural business community, served as a basis for the flood damage analysis made by the Soil Conservation Service of the U.S. Department of Agriculture. As a first step, per acre damages were computed for crop and pasture losses for three agricultural reaches of the valley. The three reaches chosen were: Reach 1 - the ponding area from State Route 408 upstream to Pioneer Road; Reach 2 - the ponding area from Pioneer Road to approximately 8000 feet upstream of Groveland; Reach 3 - the area susceptable to overland flooding from 8000 feet upstream of Groveland to the upstream limits of the study area at White Road. This procedure involves computations of potentially damageable values by crop. The values are weighted by the percent chance of occurrence by month, land use, depth of flooding, and probability of recurrence in order to determine the average per acre damage resulting from flooding. To these values are added other on-farm losses such as damage to fences, farm roads, equipment and other items. Table C9 lists the estimated average per acre damage for selected frequencies for the three original damage reaches of the Canaseraga Valley.

TABLE C9. - Estimated average per acre damage for the three original damage reaches on long term adjusted normalized price levels.

Original reach	Frequency of events in years					
	1	2	5	10	20	100
	$	$	$	$	$	$
1 (1)	-	11.00	13.54	13.28	13.33	13.61
2 (2)	11.08	11.48	11.76	11.73	11.71	11.84
3 (3)	18.50	18.76	18.82	18.83	18.88	18.93

(1). Original reach 1 is the ponding area from State Route 408 upstream to Pioneer Road and includes reaches 1, 2 and 3 of the final eight damage reaches described in paragraph 61 and shown on plate C15.

(2). Original reach 2 is the ponding area from Pioneer Road to approximately 8000 feet upstream of Groveland and includes reaches 4, 5 and 6 of the final eight damage reaches.

(3). Original reach 3 is the area from approximately 8000 feet upstream of Groveland to the upstream limits of the study area at White Road and includes reaches 7 and 8 of the final eight damage reaches.

65. AVERAGE ANNUAL DAMAGES, EXISTING CONDITIONS

Initially, damage-frequency curves were determined for the three original reaches using the appropriate area inundated-frequency curves for these three reaches in conjunction with the corresponding values of the estimated per acre damage listed in table C9. The estimated average annual damage for each of these three damage reaches was determined as the area under the related damage-frequency curve.

66. In order that the index point of a given reach would be representative of both existing and improved conditions, the number of reaches and reach limits were revised. The three agricultural reaches were broken into the eight damage reaches discussed in paragraph 61 and shown on plate C15. Due to the scope of this report and the limited time available, average per acre damages for these eight reaches were not re-evaluated and were assumed to be the values determined for the corresponding original damage reaches. As an alternative method, the damage-frequency results for the three original reaches were apportioned to the eight damage reaches by land area. The resulting damage-frequency curves for the eight damage reaches are shown on plate C19. The area under each of these curves represents the estimated direct average annual damages for the considered reach. The total direct average annual damages for the eight reaches was comparable to the total as determined for the three original reaches. The indirect flood damages, e.g., those losses sustained by the industries processing and using the products that would be damaged, etc., were estimated at 10 percent of the direct damages. The estimated direct, indirect and total average annual flood damages for the eight reaches at long term adjusted normalized price levels are listed in table C10.

TABLE C10. - Estimated average annual damage, long term adjusted normalized price levels.

Reach	Average annual damage		
	Direct	Indirect (1)	
1	$ 15,850	$ 1,590	$ 17,440
2	14,010	1,400	15,410
3	1,390	140	1,530
4	10,360	1,040	11,400
5	290	30	320
6	9,250	920	10,170
7	4,330	430	4,760
8	9,170	920	10,090
Total	$ 64,650	$ 6,470	$ 71,120

(1) Estimated at 10 percent of the direct average annual damages.

BENEFITS

67. GENERAL

Benefits would be realized from several sources for the multi-purpose project proposed for the Canaseraga Valley. The estimated flood control benefits attributable to the project were provided by the Soil Conservation Service. The estimated fish and wildlife recreational benefits were provided by the U.S. Department of Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife.

68. Flood control benefits would result from the reduction of flood damages to agricultural lands by the lowering of Canaseraga Creek and tributary stages in the lower reaches of the Canaseraga Valley and protection by a levee in the upper reaches. Additional flood control benefits would be derived from changed land use and more intensive land use. The changed land use benefits would result from growing high value crops on land that is presently being used to grow lower valued crops because of the existing flood problem. The changed land use benefits are based upon the difference between the net annual incomes derived from present crops and that derived from crops which farmers indicate they would grow if assured that flooding would be limited in frequency. Where land is potentially productive, as in the Canaseraga Valley, these benefits are substantial. Closely allied to changed land use benefits are more intensive land use benefits. These benefits are derived from shifting the land to a more intensified cropping system within the same general use plan. For example, additional inputs of capital in the form of fertilizers or land treatment might be justified on the unflooded land, causing increases in yield and profitability. The benefits are again equal to the increased net income due to the more intensive use.

69. Fish and wildlife benefits would result from provision of ponding areas to be used as resting and feeding areas for migratory waterfowl during the spring and fall migration and as nesting and rearing areas for continental waterfowl during the summer. Additional benefits that would be realized from the improvement are the recreational benefits from increased bird-watching opportunity and increased waterfoul hunting opportunity. An analysis of the increase in hunter demand in the Genesee Basin indicates that the number of hunter-days for all types of hunting can be expected to increase more than threefold by the year 1990. Provided with the proposed permanent ponds, the number of waterfowl hunter-days attributable to the project can be expected to increase at least at the same rate. The project could be expected to provide at least the same increase in bird-watching opportunity.

70. AVERAGE ANNUAL FLOOD DAMAGE BENEFITS

Average annual damages to be expected under improved channel conditions were developed for the eight damage reaches of the Canaseraga Valley by the method described in paragraphs 65 and 66. The area inundated-frequency curves as determined on the "summer events" basis were used to obtain the damage-frequency curves for improved conditions. Using the "summer events" area-frequency curves for improved conditions shown on plate C18 produces benefits slightly in excess of those actually attributable to the project because the area that would be flooded to a higher stage on an annual basis and produce additional damage to nursery stock, farm roads, equipment, etc., would not be included in the damages. However, the major portion of the damages sustained would occur during the summer growing season, so use of the "summer events" curves would provide realistic values for the damages under improved conditions. The "summer events" damage-frequency curves as determined for improved conditions utilizing the appropriate area-frequency curves and per acre damage values are shown on plate C19. The area under these damage-frequency curves represents the residual direct average annual damage under improved conditions. Indirect damages were estimated to be 10 percent of the direct damages. Estimated flood benefits for the eight damage reaches of the Canaseraga Valley are given in table C11.

TABLE C11. - Estimated average annual flood benefits, long term adjusted normalized price levels.

	Average annual damages				
	With no flood (1)	With flood protection			Net
Reach	protection	Direct	Indirect	Total	Benefits
1	$ 17,440	$ 1,200	$ 120	$ 1,320	$ 16,120
2	3,690(2)	290	30	320	3,370(2)
3	1,530	negligible	negligible	negligible	1,530
4	11.400	1,110	110	1,220	10,180
5	320	negligible	negligible	negligible	320
6	10,170	500	50	550	9,620
7	4,760	300	30	330	4,430
8	10.090	700	70	770	9,320

(1) Values given were taken from table C10.

(2) Benefits for reach 2 were determined excluding the areas designated for the Fish and Wildlife Permanent Ponds I and II.

71. AVERAGE ANNUAL CHANGED LAND USE BENEFITS

Because of the existing flood problem, a substantial portion of the Canaseraga Valley farmland is presently used to grow a lower valued crop on lands capable of supporting higher valued crops. Reduction in the frequency of flooding and the duration of flooding would make this land available for higher valued crops. Landowners were interviewed to determine the type of crop they would grow on this land if the frequency of flooding would be reduced. An estimate of the acreage that would be converted to growing the higher valued crops was also obtained during the interviews. The net income to be expected for changed land use was then determined by relating the acreage involved to the per acre value of the type of crop to be grown. This procedure was also used to determine the net income under present use. The difference between the net income for changed land use and present use, discounted to reflect the time required for buildup upon completion of the improvement and further reduced to account for the added damage that would result from flooding of the changed land involved, would produce the average annual benefits for the changed land use. The buildup period was estimated to be ten years and the increase in average annual flood damage chargeable to the changed land use was estimated at ten percent of the difference in net income. Table C12 is a tabulation of the values used to obtain the changed land use benefits and the resulting benefits for the eight damage reaches of the Canaseraga Valley.

TABLE C12.

Estimated average annual change land use benefits, long term adjusted normalized price levels.

Item	Damage reach								Total
	1	2(3)	3	4	5	6	7	8	
	$	$	$	$	$	$	$	$	$
Net income - Changed land use	62,520	49,070	9,970	37,920	28,030	44,580	76,630	404,480	713,200
Net income - Present use	57,130	44,300	9,110	32,940	26,290	38,740	71,140	395,420	675,070
Difference in Net income	5,390	4,770	860	4,980	1,740	5,840	5,490	9,060	38,130
Discounted for 10 year buildup at 6% (1)	5,280	4,680	840	4,880	1,710	5,730	5,380	8,880	37,380
Less: Added flood damage (2)	530	470	80	490	170	570	540	890	3,740
Average annual benefits	4,750	4,210	760	4,390	1,540	5,160	4,840	7,990	33,640

(1) Factor = 0.98

(2) Assumed to be 10%

(3) Areas to be used for the Fish and Wildlife Permanent Ponds I and II were not included when determining the reach 2 benefits.

72. AVERAGE ANNUAL INTENSIFIED LAND USE BENEFITS

The lands that would produce changed land use benefits could also provide increases in yield and profitability through the use of more intensive production practices resulting in additional benefits from the improvement.

73. The procedure used to determine the changed land use benefits discussed in paragraph 71 was used to determine the intensified land use benefits. The net income from the changed land use was subtracted from the intensified land use to obtain the difference in net income from which the average annual benefits were determined. The resulting intensified land use benefits are presented in table C13.

TABLE C13.

Estimated average annual intensive land use benefits, long term adjusted normalized price levels.

Item	Damage Reach 1	2(4)	3	4	5	6	7	8	Total
	$	$	$	$	$	$	$	$	$
Net income - More intensive use	91.090	70,870	14,530	54,030	31,800	63,530	86,730	421,150	833,730
Net income - Changed land use (1)	62,520	49,070	9,970	37,920	28,030	44,580	76,630	404,480	713,200
Difference in net income	28,570	21,800	4,560	16,110	3,770	18,950	10,100	16,670	120,530
Discounted for 10 year buildup at 6% (2)	28,010	21,370	4,470	15,790	3,700	18,580	9,900	16,340	118,160
Less: Added flood damage (3)	2,800	2,140	450	1,580	370	1,860	990	1,630	11,820
Average annual benefits	25,210	19,230	4,020	14,210	3,330	16,720	8,910	14,710	106,340

(1) Values from table C12

(2) Factor = 0.98

(3) Assumed to be 10%

(4) Areas to be used for the Fish and Wildlife Permanent Ponds I and II were not included when determining the Reach 2 benefits.

74. ESTIMATED TOTAL FLOOD CONTROL BENEFITS

The estimated total average annual benefits for the reduction of flood losses, changed land use benefits and more intensive land use benefits are shown in table C14 for the eight damage reaches of the Canaseraga Valley.

TABLE C14. - Estimated total average annual benefits at long term adjusted normalized price levels.

Reach	Average annual benefits: Reduction of flood losses	Changed land use	More intensive land use	Totals
1	$ 16,120	$ 4,750	$ 25,210	$ 46,080
2	3,370	4,210	19,230	26,810
3	1,530	760	4,020	6,310
4	10,180	4,390	14,210	28,780
5	320	1,540	3,330	5,190
6	9,620	5,160	16,720	31,500
7	4,430	4,840	8,910	18,180
8	9,320	7,990	14,710	32,020
Totals	$ 54,890	$ 33,640	$ 106,340	$194,870

75. FISH AND WILDLIFE HABITAT BENEFITS

The information presented was provided by the Fish and Wildlife Service of the U.S. Department of Interior in a Planning Aid Letter dated 15 June 1967 to be used for project planning purposes only and not to be used in lieu of an approved report. A portion of the discussion presented herein is taken verbatim from the Planning Aid Letter provided by the Fish and Wildlife Service.

76. Moderate fishery values in the lower reaches of the Canaseraga Valley are greatly outweighed by the waterfowl values that would be realized from the project. Therefore, it was considered that the latter should be conserved and developed even at the expense of some losses to the fisheries.

77. The poorly drained area from near State Route 408 upstream to Groveland, known locally as the Groveland Flats, has throughout the years provided habitat where thousands of migrating waterfowl have found a place to rest and feed. Primarily, this has been a stopping point on spring migration, due to the presence of ponding waters at that time. A relatively small amount of nesting has occurred; this has been limited, as has fall migration use, by the lack of ponded waters in the summer and fall. Assuming that conditions continue to be about what they have been in the past, future use of the area is likely to remain at about the present level.

78. The average daily numbers of ducks and geese which presently use the area during different periods of the year are shown in table C15. In order to be able to draw comparisons with conditions which would exist with the project, this use has been related, insofar as possible, to the contemplated future pools. Since there is no ponded water at present, except in the spring, use during the nesting and rearing season and during fall migration could only be shown under the heading "Groveland Flats, General." The number of young produced means, in this case, the number reared to flight stage. Under present conditions and, it is assumed, in the future without the project, this number is considered to be five birds per breeding pair. Table C16, which shows the number of waterfowl-use days projected without the project, is developed directly from the data in table C15.

TABLE C15. - Average daily numbers of waterfowl without the project

	Waterfowl Populations									
	Spring Influx		Breeding Birds		Young Produced		Late Summer Use		Fall Influx	
	Ducks	Geese	Ducks	Geese	Ducks	Geese	Ducks	Geese	Ducks	Geese
No. of Days	30	40	79	None	40	None	30	None	60	60
Location Acres			Numbers of Birds							
Pool I 740	2,400	3,000								
Pool II 400	1,300	2,000								
Pool III 2,000	6,300	10,000								
Goveland Flats			200	-	500	-	200	-	500	250
(General)										
Totals	10,000	15,000	200		500		200		500	250

Table C16. - Annual number of waterfowl - use days without the project

	Waterfowl - Use Days									
	Spring Influx		Breeding Birds		Young Produced		Late Summer Use		Fall Influx	
	Ducks	Geese	Ducks	Geese	Ducks	Geese	Ducks	Geese	Ducks	Geese
Location										
Pool I	72,000	120,000								
Pool II	39,000	80,000								
Pool III	189,000	400,000								
Groveland Flats			15,800	-	20,000	-	6,000	-	30,000	15,000
(General)										
Totals	300,000	600,000	15,800	-	20,000		6,000		30,000	15,000

Grand Total 986,800 waterfowl - use days (1 waterfowl - use day = 1 bird for 1 day)

79. Values for habitat such as the above cannot be measured directly in dollars. Using the least-cost alternative justifiable expenditure method, a minimum value of 12.4 cents per waterfowl-use day was developed. Table C17 presents the annual dollar value for habitat without the project. The dollar values listed were determined by application of the minimum value per waterfowl-use day to the number of use-days shown in table C16.

Table C17. - Annual without the project waterfowl use days and estimated habitat value in dollars (1)

Location	Spring Migration		Nesting & Rearing		Later Summer Use		Fall Migration		Total Use & Value	
	Waterfowl Days	Dollar Value	Waterfowl Days	Dollar Value	Waterfowl Days	Dollar Value	Waterfowl Days	Dollar Value	Waterfowl Days	Dollar Value
		$		$		$		$		$
Pool I	192,000	23,800							192,000	23,800
Pool II	119,000	14,800							119,000	14,800
Pool III	589,000	73,000							589,000	73,000
Groveland Flats										
General	-		35,800	4,400	6,000	700	45,000	5,600	86,800	10,700
Totals	900,000	111,600	35,800	4,400	6,000	700	45,000	5,600	986,800	122,300

(1) Dollar value based on the minimum value of $0.124 per waterfowl use day.

80. The plan of improvement for the local flood protection project in the Canaseraga Valley would provide for alleviating the flood problems for the agricultural interests and at the same time improve conditions for wildlife, particularly waterfowl. Under existing conditions the ponding areas that form in the lower reaches of the valley in the spring provide a resting and feeding area for migratory waterfowl. However, lack of ponded waters during the summer and fall preclude the use of this area as a major nesting and rearing area during the summer or as a resting and feeding area for waterfowl during the fall migration. Provision of the three ponding areas shown on plate C10 would greatly enhance the area for the above summer and fall purposes and provide a larger and more reliable area to be used by the waterfowl during the spring migration. Permanent Ponds I and II would provide areas to be used during the summer and fall. The Temporary Pond III would be maintained until some mutually agreed upon date in the spring by the agricultural and wildlife interests. This pond would be of considerable area and would provide for a resting and feeding area during the spring migration.

81. The information presented for conditions with the proposed improvement was determined assuming that the Temporary Pond III would not be drained until 15 May each year, at which time most of the birds will have departed from the area and the few remaining could move over to one of the permanent ponds. If Temporary Pond III were to be drained by 15 April, it was estimated that the ultimate waterfowl habitat value indicated would be cut in half.

82. Table C18 shows the ultimate average daily number of waterfowl with the project. The ultimate is expected to be realized about 20 years after completion of the project. Table C19 is a tabulation of the number of waterfowl-use days annually for ultimate conditions. It is anticipated that about 58, 85 and 96 percent of the ultimate use values will have developed within 5, 10 and 15 years, respectively, after completion of the project.

TABLE C18. - With the project, ultimate average daily number of waterfowl

Waterfowl Populations

		Spring Influx		Breeding Birds		Young Produced		Late Summer Use		Fall Influx	
		Ducks	Geese	Ducks	Geese	Ducks	Geese	Ducks	Geese	Ducks	Geese
No. of Days		30	40	79	79	40	40	30	30	60	60
Location	Acres			Number of Birds							
Pool I	740	3,500	5,200	500	130	1,000 1/	230 2/	300	120	7,000	4,000
Pool II	400	2,000	3,000	250	70	500 1/	120 2/	150	60	6,000	2,000
Pool III	2,000	9,500	14,200	300	30	600 1/	50 2/	-	30	1,000	500
Totals		15,000	22,400	1,050	230	2,100	400	450	210	14,000	6,500

1/ Assumed average 4 ducklings per breeding pair reared to flight stage (rounded to nearest 100).

2/ Assumed average 3.5 goslings per breeding pair reared to flight stage (rounded to nearest 10).

TABLE C19. - Ultimate number of waterfowl-usedays annually with the project

Waterfowl-use days

	Spring Influx		Breeding Birds		Young Produced		Late Summer Use		Fall Influx	
	Ducks	Geese	Ducks	Geese	Ducks	Geese	Ducks	Geese	Ducks	Geese
Location										
Pool I	105,000	208,000	39,500	10,300	40,000	9,200	9,000	3,600	420,000	240,000
Pool II	60,000	120,000	19,800	5,500	20,000	4,800	4,500	1,800	360,000	120,000
Pool III	285,000	568,000	23,700	2,400	24,000	2,000	-	900	60,000	30,000
Totals	450,000	896,000	83,000	18,200	84,000	16,000	13,500	6,300	840,000	390,000

Grand Total 2,796,000 waterfowl-use days 20 years after completion of the project.

83. Table C20 presents the annual dollar value for habitat under ultimate conditions which would be realized about 20 years after completion of the project. The dollar values shown were determined by applying the minimum value of 12.4 cents per waterfowl-use day to the number of use-days.

84. ESTIMATED EQUIVALENT AVERAGE ANNUAL HABITAT BENEFITS OVER THE LIFE OF PROJECT

Due to the growth period required to obtain the ultimate dollar values with the project, a discounting procedure was required to determine the equivalent average annual benefits for the habitat. Plotting of the dollar values estimated for 5, 10, 15 and 20 years after completion of the project indicated that an assumed straight line growth rate for a period of 15 years would produce a reasonable estimate of the average annual habitat benefits.

85. Using a growth period of 15 years, a project life of 50 years and an annual interest rate of 3-1/8 percent, equivalent average annual waterfoul habitat benefits of $171,220 were determined as shown in table C21. 4 5/8 %

TABLE C21. - Estimated equivalent average annual habitat benefits

Total ultimate dollar value with the project	$346,900
Without the project dollar value	$122,300
Maximum annual amount to be discontinued = a	$224,600
Project life = n	50 years
Growth period = g	15 years
Annual interest rate = i	3-1/8 percent
Average annual equivalent factor = Ef	0.7623392
Average annual benefits = a(Ef)	$171,220

86. RELATED BIRD-WATCHING AND HUNTING BENEFITS

During spring migration, the presence of thousands of waterfowl attracts people from as far away as Buffalo and Rochester. A survey by the New York State Division of Fish and Game in 1964 determined that at least 15,000 bird-watching days were enjoyed because of the birds at Groveland Flats that year. It is considered that this probably will be about the level of this type of use in the future without the project.

87. Groveland Flats also provides for a considerable amount of waterfowl-hunting opportunity at present, both directly through hunting use of the area itself and indirectly because it has a considerable effect on holding birds in the general area although they move out to feed in fields and waters which may be quite a distance away. Direct use of the area for hunting is estimated at 1,000 days annually, while the additional use of areas within the field of influence due to the holding effect is estimated to be 1,500 hunter-days.

88. On the basis that the net value of a recreational day of bird-watching in the Groveland Flats area is $0.50 and that a day of waterfowl-hunting is $4.00, the respective annual values of these two forms of recreation without the project amount to $7,500 (15,000 bird-watching days x $0.50 per day) and $10,000 (2,500 hunter days x $4.00 per day).

89. As previously stated in paragraph 69, bird-watching and hunter-use days could be expected to at least triple if the proposed project were constructed. This would increase the bird-watching use days to 7,500 (2,500 x 3) annually with the project. It was estimated that a 20-year period after completion of the project would be required to attain this useage and about 56, 84 and 96 percent of the 20-year value would be realized in 5, 10 and 15 years, respectively, after completion of the project.

90. The related monetary values with the project for bird-watching and waterfowl hunting would be $22,500 (45,000 bird-watching days x $0.50 per day) and $30,000 (7,500 hunter-days x $4.00 per day), respectively. Table C22 summarize the annual values for these benefits with and without the project. The bird-watching and hunting values were combined in the table since it was estimated that the growth rates to obtain the ultimate values would be the same.

TABLE C22. - Summary of estimated annual bird-watching and waterfowl hunting values

Condition	Bird-watching: Use days	Bird-watching: Dollar(1) value	Waterfowl hunting: Use days	Waterfowl hunting: Dollar(2) value	Total dollar value: birdwatching & hunting
With the project	45,000	$22,500	7,500	$30,000	$52,500(3)
Without the project	15,000	7,500	2,500	$10,000	$17,500

(1) Estimated at $0.50 per use day
(2) Estimated at $4.00 per use day
(3) Annual dollar value 20 years after completion of project = $52,500. It is expected that about 56,84 and 96 percent of the 20-year value will have developed within 5, 10 and 15 years respectively, after completion of the project.

91. ESTIMATED EQUIVALENT AVERAGE ANNUAL BIRD-WATCHING AND HUNTING BENEFITS OVER THE LIFE OF PROJECT

Again, due to the growth period required to attain the ultimate use with the project, discounting was required to determine the equivalent average annual benefits attributable to the above interests. As was the case in the determination of the average annual waterfowl habitat benefits, plotting of the dollar values estimated for 5, 10, 15 and 20 years after completion of the project indicated that a straight line growth rate for a period of 15 years would produce a reasonable estimate of the average annual bird-watching and hunting benefits. Therefore, using a growth period of 15-years, a project life of 50 years and an annual interest rate of 3-1/8%, equivalent average annual bird-watching and hunting benefits of $26,680 were determined as shown in table C23.

4 5/8 %

TABLE C23. - Estimated equivalent average annual bird-watching and waterfowl hunting benefits

Total dollar value with the project (1)	\$52,500
Without the project dollar value (1)	\$17,500
Maximum annual amount to be discounted = a	\$35,000
Project life = n	50 years
Growth period = g	15 years
Annual interest rate = i	4-3/8 3-1/8 percent
Average annual equivalent factor = Ef	0.7623392
Average annual benefits = a(Ef)	\$26,680

(1) From table C22

92. ESTIMATED TOTAL FISH AND WILDLIFE RECREATIONAL BENEFITS

The estimated total equivalent average annual fish and wildlife benefits attributable to waterfowl habitat and bird-watching and waterfowl hunting are shown in table C24.

TABLE C24. - Estimated total equivalent average annual fish and wildlife benefits

Average annual habitat benefits (1)	\$171,220
Average annual bird-watching and waterfowl hunting benefits (2)	26,680
Total fish and wildlife benefits	\$197,900

(1) From table C21.
(2) From table C23.

93. Comparison of the estimated total average annual flood control benefits of $194,870 shown in table C14 with the estimated total average annual fish and wildlife recreational benefits of $197,900 shown in table C24 shows that slightly more than 50 percent of the total project benefits would be provided by the fish and wildlife interests. Normally, a project could not be recommended if the general recreational benefits provide for 1/2 of the total project benefits. However, a large portion of the total fish and wildlife benefits would result from enhancement to migratory waterfowl. On the basis that the preservation and enhancement of migratory waterfowl would be of national significance, it was considered that this portion of the fish and wildlife benefits would not be classified as general recreational benefits and therefore should not be included when comparing the estimated total average annual fish and wildlife benefits to the total project benefits. Using this criterion, it was determined that the remaining general recreational benefits would provide for considerably less than 50 percent of the total fish and wildlife benefits over flood control benefits would only be $3,030 ($197,900-$194,870) it was considered that it would not be necessary to separate the benefits attributable to the migratory interests from the total fish and wildlife benefits.

ESTIMATES OF COST

94. GENERAL

A detailed cost estimate was obtained for the plan of improvement that would provide the most favorable benefit-cost ratio while providing the functions required for flood control and fish and wildlife interests. This plan, described in paragraphs 17 through 24, would consist of about 20 miles of channel improvement, replacement of several bridges, construction of weirs and control structures, construction of a gated retention structure across the lower end of the Canaseraga Valley and provision of fish and wildlife ponds upstream of the retention structure. The improvement would provide flood protection for the agricultural interests against a 5-year event on the "summer events" basis and would provide permanent ponding areas to serve the fish and wildlife interests.

95. COST ESTIMATE

Estimates of cost were based on costs of similar work in the Buffalo District and are adjusted to June 1967 price levels. Engineering, design, supervision and administration costs were based on costs of accomplishing similar work by this office. Table C25 shows estimated quantities and costs for the recommended plan of improvement. For use in allocation of costs, the table also shows estimates of cost for alternative single-purpose plans which would be necessary to provide equivalent flood control and fish and wildlife benefits.

TABLE C2[illegible]. - Estimate of costs, June 1977 price levels

	Dual-purpose plan (flood control and fish and wildlife)					Alternative single purpose plans	
	Quantity	Unit	Unit cost	Amount	Total	Flood control	Fish and wildlife
			$	$	$	$	$
LANDS							
Rights-of-way for construction and maintenance		LS		10,000		9,000	2,000
Lands purchased		LS		176,000		6,000	170,000
Contingencies		LS		35,000		3,000	33,000
Acquisition costs		LS		15,000		12,000	5,000
Total					236,000	30,000	210,000
RELOCATIONS							
Everman Road bridge		LS		83,200			
Pioneer Road bridge		LS		47,200			
Farm bridges - replace							
No. 1		LS		47,800			
No. 4		LS		37,700			
No. 6		LS		41,300			
Farm bridges - remove							
No's 2, 3, & 5	3	Ea.	500.00	1,500			
Contingencies				51,800			
Total					310,500	310,500	
CHANNELS							
Clearing	152	Acre	500.00	76,000			
Excavation - channels							
Canaseraga Creek	3,046,000	CY	0.55	1,675,300			
Kashequa Creek	58,500	CY	0.55	32,175			
Bradner Creek	71,700	CY	0.55	39,440			
State Canal	22,100	CY	0.55	12,155			
Excavation - riprap	22,290	CY	1.20	26,750			
Riprap, 18"	16,720	CY	15.25	254,980			
Filter blanket, 18"	5,570	CY	5.00	27,850			
Weir No. 1		LS		41,200			
Weir No. 2		LS		13,400			
Weir No. 3		LS		26,500			
Control Str. No. 1		LS		25,700			
Control Str. No. 2		LS		54,300			
Seeding, mulching and fertilizing	153	Acre	650.00	99,450			
Contingencies				480,800			
Total					2,886,000	2,886,000	
LEVEE							
Stripping	3,800	CY	0.80	3,040			
Excavation - borrow	36,300	CY	0.45	16,335			
Compacted embankment	30,200	CY	0.35	10,570			
Seeding, mulching and fertilizing	6	Acre	650.00	3,900			
Contingencies				6,655			
Total					40,500	40,500	
RETENTION STRUCTURE							
Earth dam							
Clearing		LS		30,000			
Stripping	42,500	CY	0.80	34,000			
Inspection trench	12,525	LF	1.50	18,788			
Excavation - borrow	473,600	CY	0.45	213,120			
Excavation - riprap	1,500	CY	1.20	1,800			
Compacted embankment	394,672	CY	0.30	118,402			
Riprap, 36"	22,250	CY	15.25	339,313			
Filter blanket, 24"	13,500	CY	5.00	67,500			
Piling, MP-22	704,000	Lbs	0.25	176,000			
Seeding, mulching and fertilizing	22	Acre	650.00	14,300			
Access road, ROB gravel	5,800	CY	0.45	2,610			
Access road, compacted	4,800	CY	0.30	1,440			
Miscellaneous items				101,727			
Spillway and Outlet works							
Care of water		LS		25,000			
Excavation - structural	25,000	CY	1.20	30,000			
Steel bearing piles	230	Ea.	795.00	182,850			
Piling cut-off, MA-22	25,750	Lbs	0.25	6,433			
Concrete - spillway	6,100	CY	26.00	158,600			
Concrete - outlet works	418	CY	60.00	25,080			
Portland cement	8,963	Bbl	5.00	44,815			
Steel reinforcement	586,620	Lbs	0.13	76,261			
Riprap	2,000	CY	15.25	30,500			
Tainter gates	2	Ea.	100,000.00	200,000			
Slide gates	3	Ea.	5,000.00	15,000			
Machinery house		LS		3,000			
Service bridge	106	LF	64.00	6,784			
Steel stairs		LS		2,500			
Steel pipe railing	280	LF	10.00	2,800			
Miscellaneous items				80,977			
Contingencies				400,400			
Total					2,410,000	2,410,000	2,410,000
FISH & WILDLIFE PONDS							
Embankment							
Stripping	72,750	CY	0.80	58,200			
Excavation - borrow	391,400	CY	0.45	176,130			
Compacted embankment	326,104	CY	0.35	114,136			
Inspection trench	43,970	LF	1.50	65,955			
Seeding, mulching and fertilizing	45	Acre	650.00	29,250			
Outlet works & Pumping Stations							
Excavate & backfill	1,140	CY	3.50	3,990			
Concrete	355	CY	70.00	24,850			
Portland cement	488	Bbl	5.00	2,440			
6" Concrete paving	320	SF	0.90	288			
Metal building, Pond I		LS		1,450			
Metal building, Pond II		LS		1,250			
5,000 gpm pump, Pond I		LS		5,500			
2,000 gpm pump, Pond II		LS		2,900			
Sluice gates, Pond I	2	Ea.	5,300.00	10,600			
Sluice gates, Pond II	1	Ea.	4,200.00	4,200			
Electrical power supply	5,000	LF	3.00	15,000			
Steel reinforcement	24,850	Lbs	0.13	3,230			
Miscellaneous items				8,031			
Contingencies				105,600			
Total				-	633,000		633,000
ENGINEERING AND DESIGN					580,000	513,000	307,000
SUPERVISION AND ADMINISTRATION					370,000	330,000	180,000
GRAND TOTAL FIRST COSTS					7,466,000 (1)	6,520,000	3,740,000
ANNUAL OPERATIONS AND MAINTENANCE							
Channels (2)					15,000	15,000	-
Retention structure (3)					6,500	6,500	6,500
Fish and Wildlife ponds					2,000	-	2,000
Inspections					200	150	50
Total					23,700	21,650	8,550

(1) First costs excludes the cost for preauthorization studies.
(2) Includes cost of maintaining channels and all appurtenances.
(3) Includes operations costs of $2,500.

96. PROJECT FORMULATION

A design discharge of 7,300 cfs at Shakers Crossing was used to design the channels for the recommended plan of improvement. It has a frequency of recurrence of 5 years on the "summer events" basis. Allocation of costs for the improvement was made on the basis of benefits expected from flood control and fish and wildlife. The proposed dual-purpose project would have a benefit-cost ratio based on allocated costs of 1.2 to 1. A plan of improvement providing 10-year flood protection would result in a substantial increase in first costs and a minimal increase in flood control benefits indicating that further increments in the degree of flood protection would further decrease the above ratio. The fish and wildlife benefits, on which the above benefit-cost ratio is based, assumes that Temporary Pond III (see plate C10) would not be drained prior to 15 May of each year. Earlier draining of this pond would decrease the above benefit-cost ratio.

PROPOSED LOCAL COOPERATION

97. GENERAL POLICY

In accordance with current policy for local improvement projects for flood control, responsible local interests would be required to furnish assurances that they will:

a. Provide without cost to the United States all lands, easements and rights-of-way necessary for the construction and maintenance of the flood control portion of the project;

b. Hold and save the United States free from all claims for damages incident to construction and operation of the project;

c. Take over, maintain and provide for operation of the project, after completion, in accordance with regulations prescribed by the Secretary of the Army:

d. Provide without cost to the United States all relocations of highways, highway bridges, buildings, and special facilities and;

e. Prescribe and enforce regulations to prevent encroachment on channels and on rights-of-way necessary to proper functioning of the project.

98. Public Law 89-72, dated 9 July 1965, requires that non-Federal interests bear not less than one-half of the separable costs of the project allocated to fish and wildlife enhancement. It was considered that the lands required for the permanent fish and wildlife ponds (see plate C10) would be separable costs to be allocated to fish and wildlife. On this basis, responsible local interests would be required to furnish assurances that they will bear 50 percent of the cost of lands necessary for the establishment of the fish and wildlife ponds in addition to 50 percent of the cost of the structures required to establish the ponds.

ALLOCATION OF COSTS

99. GENERAL

Initial studies on Canaseraga Creek were directed toward development of plans to alleviate the flood problem. The flood control plan developed for protection of the Canaseraga Valley requires a retention structure to control the outflow from Canaseraga Creek into the Genesee River. This feature would be common to a fish and wildlife improvement by providing a controlled ponding area to be used by waterfowl. No changes in the plan of improvement for flood control would be required. However, certain features would be added to the improvement to obtain the recreational benefits from fish and wildlife. Sizable benefits would be realized from the use of the improvement by fish and wildlife interests. Studies were made to determine the amount of benefits that would result if the fish and wildlife use was developed with flood control in a dual-purpose project, and to determine the appropriate related allocation of project costs between the purposes.

100. Costs of the dual-purpose project were allocated first to each purpose, and then apportioned between Federal and non-Federal interests.

101. ESTIMATE OF COSTS AND BENEFITS FOR MULTIPLE-PURPOSE PROJECT

Table C26, following, summarizes the estimated first costs, annual maintenance costs and annual benefits for a multiple-purpose project.

TABLE C26. - Estimate of costs and benefits for multiple-purpose project

Construction costs:	
Lands	$ 236,000
Relocations	310,500
Channels	2,886,000
Levee	40,500
Retention structure	2,410,000
Fish and wildlife facilities	633,000
Engineering and design	580,000
Supervision and administration	370,000
Total	$7,466,000
Annual operations and maintenance costs:	$ 23,700
Annual benefits:	
Flood control	$ 194,870
Fish and wildlife	197,900
Total	$ 392,770

102. For allocation, flood control and fish and wildlife were considered the purposes of the project. Costs for project facilities needed to fully develop these two purposes were allocated to these purposes on the basis of separable costs and remaining benefits. All computations to determine annual charges for allocation of the first costs assumed an interest rate of 3-1/8 percent and a 50-years life. For all features, a two-year construction period was assumed, and interest for one year was added to first costs to determine investment costs.

103. As the first step in allocation of costs to the purposes, estimates of costs were developed for alternate projects which would produce single-purpose benefits equal to those produced by the dual-purpose project (see table C25). The total estimated first and annual costs for alternative single-purposes flood control and fish and wildlife projects are given in table C27. In the allocation, made on the basis of annual costs, the amount allocable to each purpose was limited by these alternate annual charges or by the related benefits, which ever were smaller. The single-purpose flood control project would not be justified, so allocation of the dual-purpose project costs to that purpose was limited by the flood control benefits developed.

TABLE C27. Annual charges for alternative single purpose projects

Item	Flood control	Fish and wildlife
	$	$
First cost	6,520,000	3,740,000
Interest during construction	203,800	116,900
Investment	6,723,800	3,856,900
Annual charges:		
Interest	210,120	120,530
Amortization	57,420	32,940
Operation and maintenance	21,650	8,550
Total	289,190	162,020

104. Next, separable first costs and annual costs for each purpose were obtained by subtracting the costs of the alternate single-purpose plan from the costs of the dual-purpose project. The estimated separable first costs and separable annual costs for each purpose are given in table C28.

TABLE C28. - Annual charges for separable project costs

	Dual-purpose project			
	Separable costs			
	Flood control	Fish and wildlife	Joint use costs	Total
ESTIMATED COSTS				
	$	$	$	$
Construction expenditures	3,726,000(1)	946,000(2)	2,794,000	7,466,000
Interest during construction	116,400	29,600	87,300	233,300
Investment	3,842,400	975,600	2,881,300	7,699,300
Annual charges:				
Interest	120,080	30,490	90,040	240,610
Amortization	32,810	8,330	24,610	65,750
Operation and maintenance	15,150	2,050	6,500	23,700
Total	168,040	40,870	121,150	330,060

(1) Estimated first costs for single purpose fish and wildlife project = $3,740,000

(2) Estimated first costs for single purpose flood control project = $6,520,000

105. Finally, the separable annual costs were subtracted from the annual benefits limited as described in paragraph 103. The non-separable dual-purpose project costs were allocated in proportion to the amounts of remaining benefits.

106. Annual costs of operation and maintenance of the dual-purpose project were estimated and allocated by the same method as the annual construction charges. The separable annual maintenance costs were assigned directly to their respective purposes. The remaining (joint) annual maintenance costs were then allocated on the basis of the benefits remaining after total separable annual costs were subtracted.

107. The allocated maintenance costs were subtracted from the allocated total annual costs, and the total first costs allocated to each purpose in proportion to the remainder. The allocation computations as described above are shown in table C29.

TABLE C29. - Allocation of costs to purposes

	Flood control	Fish and Wildlife	Dual purpose
ALLOCATION COMPUTATION			
	$	$	$
First costs, alternative projects	6,520,000	3,740,000	7,466,000
Annual charges including operations and maintenance, alternative projects	289,190	162,020	330,060
Annual maintenance, alternative projects	21,650	8,550	23,700
Total annual benefits	194,870	197,900	392,770
Allocation of annual charges dual-purpose project:			
1. Benefits	194,870	197,900	
2. Alternative costs	289,190	162,020	
3. Benefits limited by alternative costs	194,870	162,020	
4. Separable costs	168,040	40,870	208,910
5. Remaining benefits	26,830	121,150	147,980
6. % distribution of item 5	18.13	81.87	100.00
7. Allocated joint costs	21,960	99,190	121,150
8. Total allocation	190,000	140,060	330,060
Allocation of maintenance, dual-purpose projects:			
9. Separable costs	15,150	2,050	17,200
10. % joint costs, item 6	18.13	81.87	100.00
11. Allocated joint costs	1,180	5,320	6,500
12. Total allocation	16,330	7,370	23,700
Allocation of first costs, dual-purpose project:			
13. Allocated annual charges	190,000	140,060	330,060
14. Allocated maintenance	16,330	7,370	23,700
15. Remainder	173,670	132,690	306,360
16. % distribution of item 15	56.69	43.31	100.00
17. Allocated first costs	4,232,500	3,233,500	7,466,000

108. APPORTIONMENT OF COSTS TO INTERESTS

The estimated apportionment of costs to interests for the dual-purpose project was based on the following criteria:

a. Flood control - The non-Federal share of the flood control costs would include the costs of lands, easements and rights-of-way, necessary relocations (excluding removal of three farm bridges) and the annual maintenance cost allocated to flood control less $150 for Federal inspections. On this basis, the non-Federal flood control costs would be $27,000 for lands, $309,000 for relocations and annual maintenance charges amounting to $16,180. The remaining flood control costs would be Federal.

b. Fish and Wildlife - The non-Federal share of the fish and wildlife costs would include one-half of the separable costs chargeable to fish and wildlife and the annual operations and maintenance cost allocated to fish and wildlife less $50 for Federal inspections. Therefore, the non-Federal share of the fish and wildlife first costs of $946,000 would include separable costs of $473,000, including 50 percent of the land costs, and annual operations and maintenance costs would be $7,320. The remaining costs would be Federal.

109. Based on the allocation shown in table C29, non-Federal interests would be allocated $809,000 of the $7,466,000 first costs for the development of the two project purposes. Of this amount, $440,000 represents costs of lands and relocations. The balance of the non-Federal responsibility, $369,000 may be met by a cash contribution toward Federal construction costs, construction of equivalent work or any suitable combination thereof.

110. The total estimated cost for operation and maintenance of the multiple-purpose project would be $23,700. In accordance with the allocation to project purposes, responsibility for maintenance costs would be divided between Federal and non-Federal interests as follows:

TABLE C30. - Allocation of operations and maintenance costs

Item	Federal	Non-Federal(1)	Total
	$	$	$
Flood control	150	16,180	16,330
Fish and wildlife	50	7,320	7,370
	200	23,500	23,700

(1) Includes $2,500 for providing for operation of the retention structure which may be accomplished by federal interests

111. The final breakdown of the first and annual costs for the two purposes of the dual-purpose project, the applicable benefits, and the benefit-cost ratio for each purpose and for the dual-purpose project, is shown in table C31. All computations to determine annual charges assumed a Federal interest rate of 3-1/8 percent, a non-Federal interest rate of 3-1/8 percent and a 50-year project life. A two-year construction period was assumed for all features, and interest for one year was added to the first costs to determine the investment costs.

TABLE C31. - Summarized allocation

Item	Flood control	Fish and wildlife	Total
	$	$	$
ALLOCATED FIRST COSTS			
Federal	3,896,500	2,760,500	6,657,000
Non-Federal	336,000	473,000	809,000
	4,232,500	3,233,500	7,466,000
INVESTMENT COSTS			
Federal	4,018,200	2,846,800	6,865,000
Non-Federal	346,500	487,800	834,300
	4,364,700	3,334,600	7,699,300
ANNUAL COSTS			
Interest & amortization			
Federal	159,890	113,280	273,170
Non-Federal	13,780	19,410	33,190
Maintenance	16,330	7,370	23,700
	190,000	140,060	330,060
ANNUAL BENEFITS	194,870	197,900	392,770
BENEFIT-COST RATIO	1.03	1.4	1.2

CONCLUSION

112. A dual-purpose plan of improvement on Canaserage Creek in the Canaseraga Valley from the mouth upstream to near Woodsville would be economically justifiable. The plan would consist of enlargement and straightening of approximately 20 miles of channels, provision of a retention structure with appurtenances near the downstream end of the study area and provision of fish and wildlife ponds upstream of the retention structure. This plan provides a feasible solution to the flood problem in the Canaseraga Valley and would produce sizable additional benefits attributable to fish and wildlife interests. Annual costs are estimated at $330,060 and annual benefits at $392,770. The ratio of benefits to costs would be 1.2 to 1.

COORDINATION WITH OTHER AGENCIES

113. Determination of the plan of improvement for the local protection project on Canaserage Creek has been the responsibility of the Corps of Engineers through the chairing of Task Group No. 3. However, basic criteria for the proposed plan of improvement - e.g., the minimum degree of flood protection required, the ponding area requirements, etc. - were established by the Soil Conservation Service of the U. S. Department of Agriculture, the Bureau of Sport Fisheries and Wildlife of the Fish and Wildlife Service of the U. S. Department of Interior, and the Division of Fish and Game of the Department of Conservation of the State of New York. These agencies also provided considerable information from which the project benefits were determined.

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GENESEE RIVER BASIN COMPREHENSIVE STUDY OF WATER AND RELATED LA--ETC(U)
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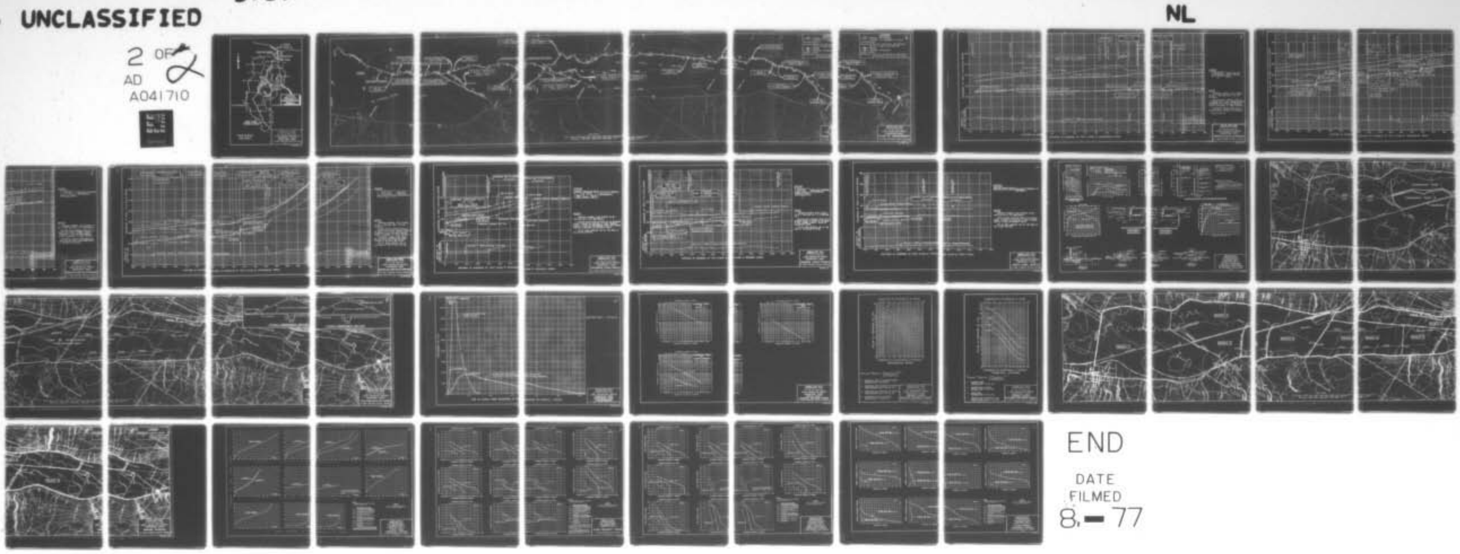

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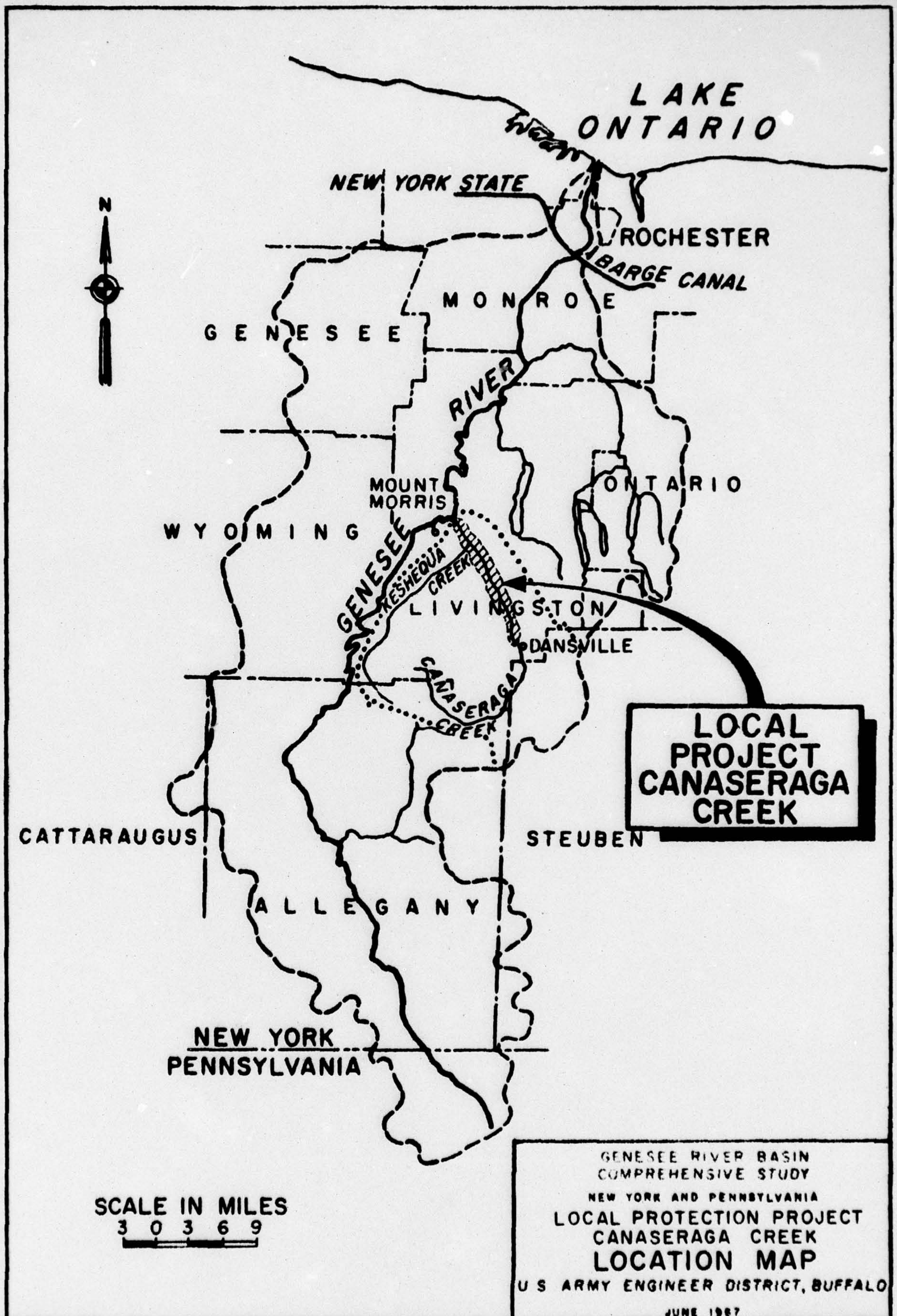
LAKE ONTARIO
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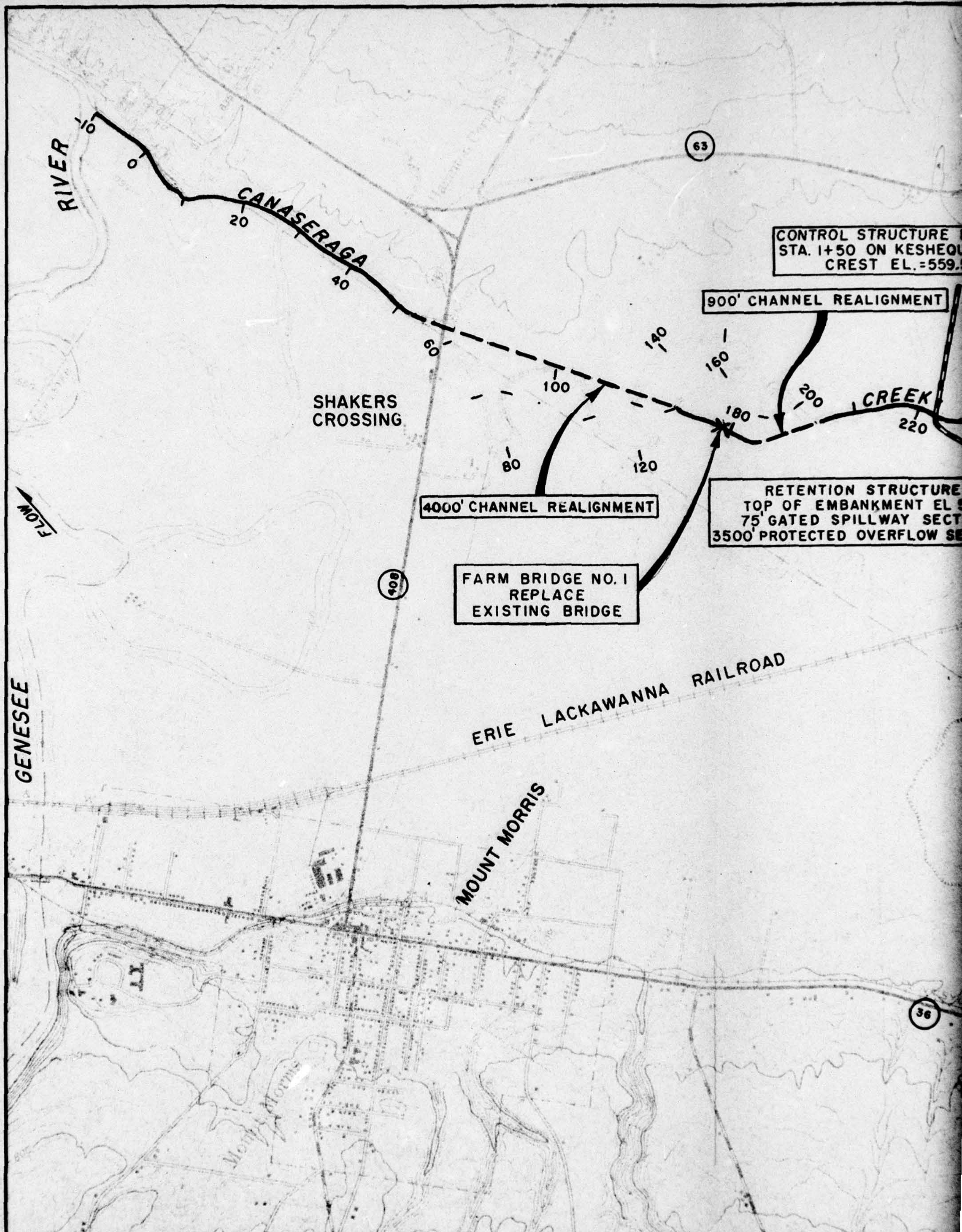
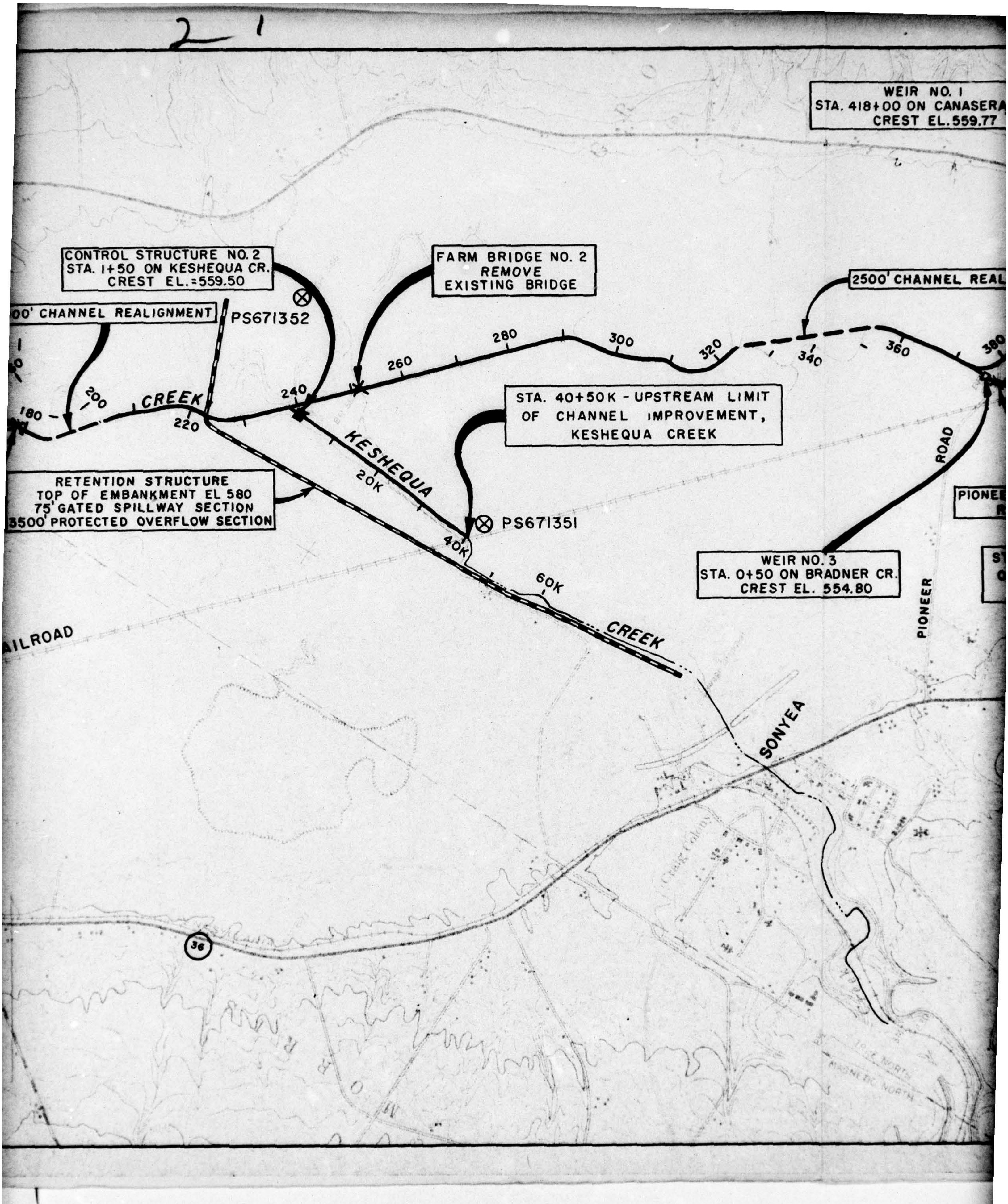
N
ROCHESTER
BARGE CANAL
MONROE
GENESEE
RIVER
ONTARIO
MOUNT MORRIS
WYOMING
GENESEE
KESHEQUA CREEK
LIVINGSTON
DANSVILLE
CANASERAGA CREEK
LOCAL PROJECT CANASERAGA CREEK
CATTARAUGUS
STEUBEN
ALLEGANY
NEW YORK
PENNSYLVANIA
SCALE IN MILES
3 0 3 6 9
GENESEE RIVER BASIN
COMPREHENSIVE STUDY
NEW YORK AND PENNSYLVANIA
LOCAL PROTECTION PROJECT
CANASERAGA CREEK
LOCATION MAP
U S ARMY ENGINEER DISTRICT, BUFFALO
JUNE 1967

PLATE C1

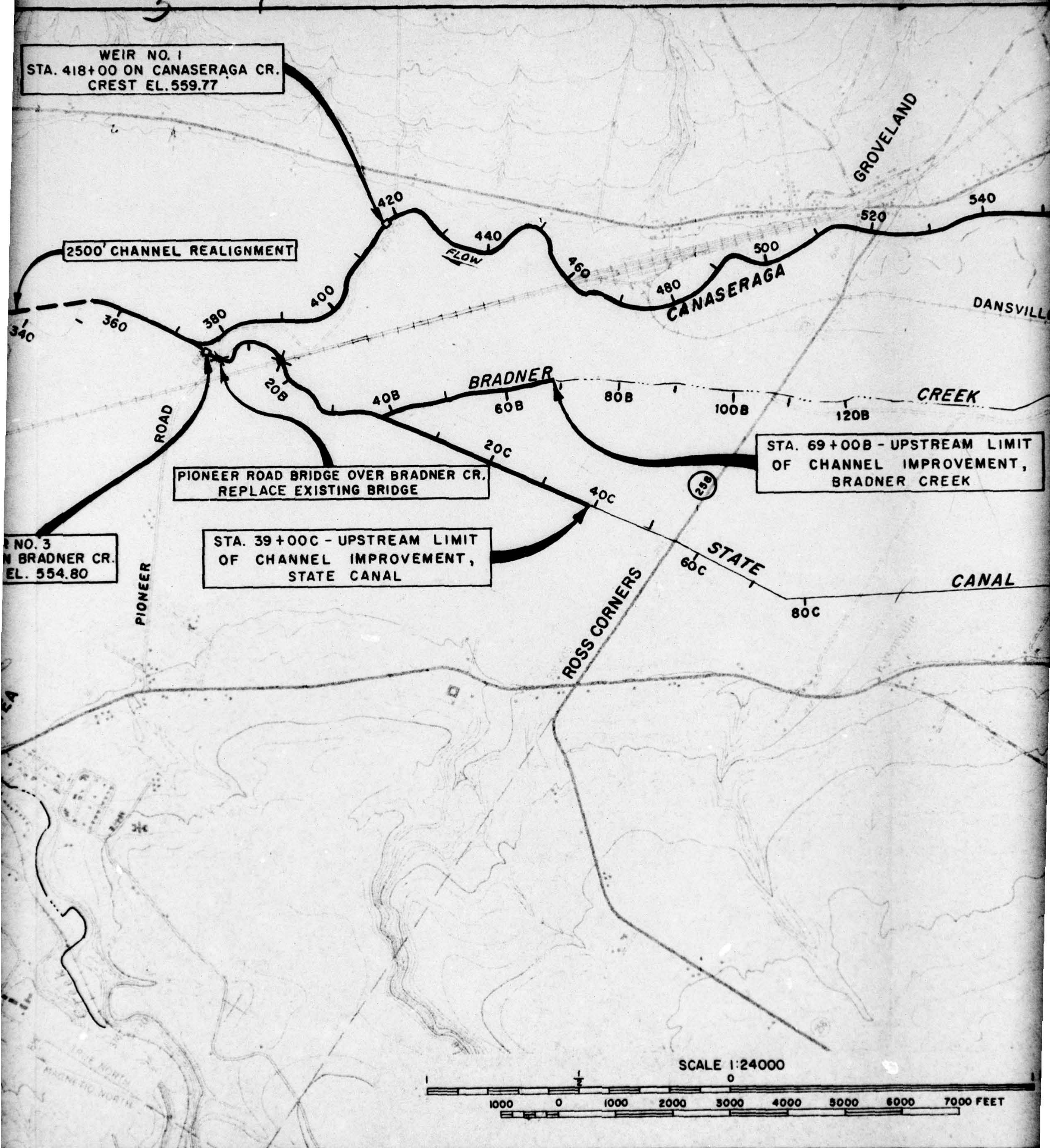


CONTROL STRUCTURE N
STA. 1+50 ON KESHEQU
CREST EL.=559.5
900' CHANNEL REALIGNMENT
CANASERAGA
CREEK
RIVER
GENESEE
SHAKERS CROSSING
4000' CHANNEL REALIGNMENT
RETENTION STRUCTURE
TOP OF EMBANKMENT EL
75' GATED SPILLWAY SECT
3500' PROTECTED OVERFLOW SE
FARM BRIDGE NO. 1
REPLACE
EXISTING BRIDGE
FLOW
ERIE LACKAWANNA RAILROAD
MOUNT MORRIS
63
408
36
-10
0
20
40
60
80
100
120
140
160
180
200
220

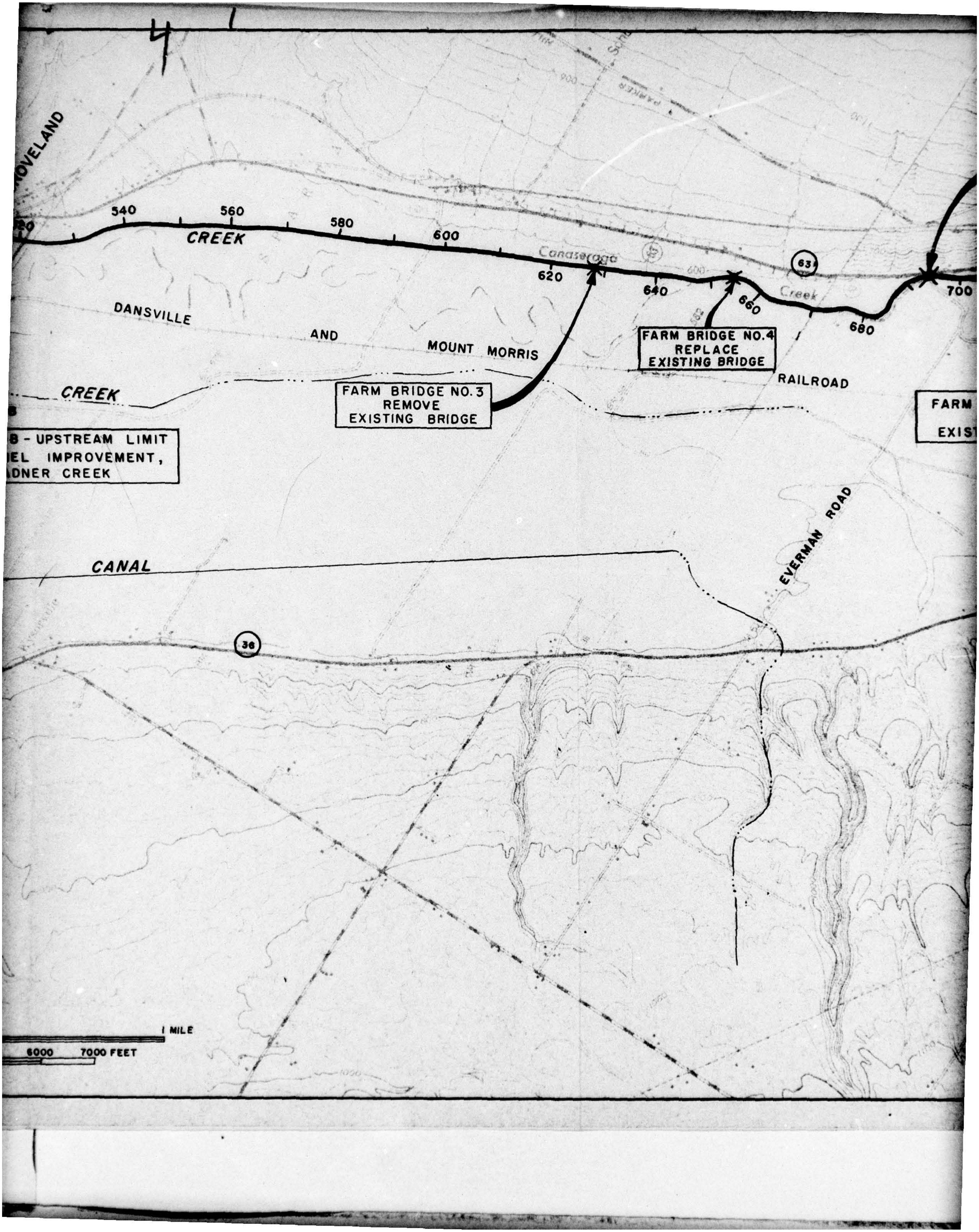


2 1
WEIR NO. 1
STA. 418+00 ON CANASERA
CREST EL. 559.77
CONTROL STRUCTURE NO. 2
STA. 1+50 ON KESHEQUA CR.
CREST EL.=559.50
FARM BRIDGE NO. 2
REMOVE
EXISTING BRIDGE
2500' CHANNEL REAL
00' CHANNEL REALIGNMENT
PS671352
280
300
320
340
360
380
260
240
200
180
220
CREEK
STA. 40+50K - UPSTREAM LIMIT
OF CHANNEL IMPROVEMENT,
KESHEQUA CREEK
KESHEQUA
20K
ROAD
RETENTION STRUCTURE
TOP OF EMBANKMENT EL 580
75' GATED SPILLWAY SECTION
3500' PROTECTED OVERFLOW SECTION
PS671351
40K
60K
WEIR NO. 3
STA. 0+50 ON BRADNER CR.
CREST EL. 554.80
PIONEE
PIONEER
AILROAD
CREEK
SONYEA
36

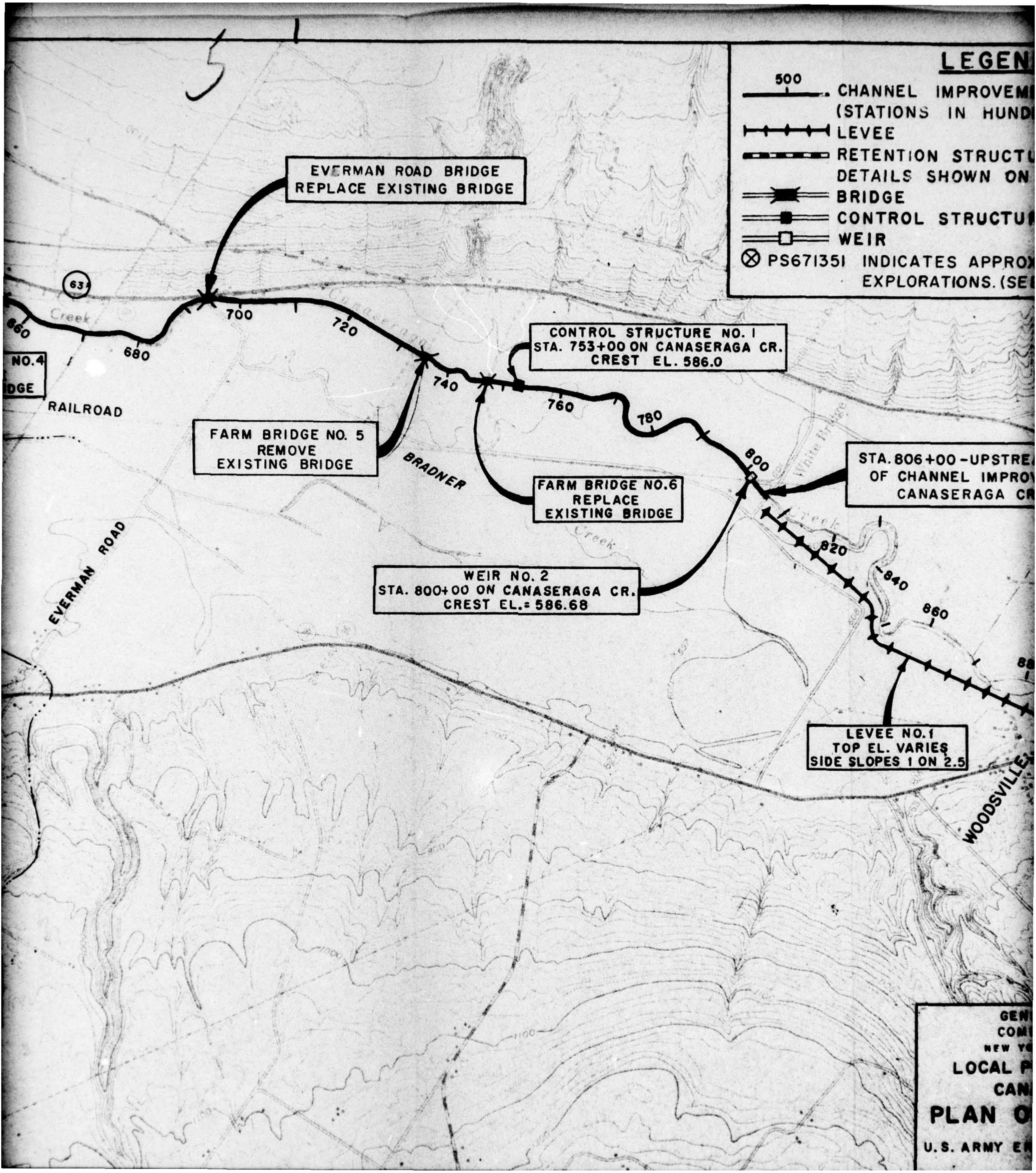
3



WEIR NO. 1
STA. 418+00 ON CANASERAGA CR.
CREST EL. 559.77
2500' CHANNEL REALIGNMENT
GROVELAND
420
440
FLOW
460
480
500
520
540
CANASERAGA
DANSVILLE
340
360
380
400
20B
40B
60B
80B
100B
120B
BRADNER
CREEK
ROAD
PIONEER ROAD BRIDGE OVER BRADNER CR.
REPLACE EXISTING BRIDGE
STA. 69+00B - UPSTREAM LIMIT
OF CHANNEL IMPROVEMENT,
BRADNER CREEK
20C
40C
60C
80C
258
NO. 3
N BRADNER CR.
EL. 554.80
STA. 39+00C - UPSTREAM LIMIT
OF CHANNEL IMPROVEMENT,
STATE CANAL
STATE
CANAL
PIONEER
ROSS CORNERS
SCALE 1:24000
1000
0
1000
2000
3000
4000
5000
6000
7000 FEET



4
NOVELAND
540
560
580
600
620
640
660
680
700
CREEK
Canaseraga
Creek
PARKER
63
DANSVILLE
AND
MOUNT MORRIS
RAILROAD
FARM BRIDGE NO.4
REPLACE
EXISTING BRIDGE
FARM BRIDGE NO.3
REMOVE
EXISTING BRIDGE
FARM
EXIST
CREEK
8 - UPSTREAM LIMIT
IEL IMPROVEMENT,
ADNER CREEK
CANAL
EVERMAN ROAD
36
1 MILE
6000
7000 FEET


5
LEGEND
500
CHANNEL IMPROVEM
(STATIONS IN HUND
LEVEE
RETENTION STRUCTU
DETAILS SHOWN ON
BRIDGE
CONTROL STRUCTU
WEIR
PS671351 INDICATES APPROX
EXPLORATIONS. (SE
EVERMAN ROAD BRIDGE
REPLACE EXISTING BRIDGE
63
Creek
660
680
700
720
740
760
780
800
820
840
860
NO.4
DGE
RAILROAD
CONTROL STRUCTURE NO. 1
STA. 753+00 ON CANASERAGA CR.
CREST EL. 586.0
FARM BRIDGE NO. 5
REMOVE
EXISTING BRIDGE
BRADNER
FARM BRIDGE NO.6
REPLACE
EXISTING BRIDGE
Creek
STA. 806+00 - UPSTRE
OF CHANNEL IMPROV
CANASERAGA CR
EVERMAN ROAD
WEIR NO. 2
STA. 800+00 ON CANASERAGA CR.
CREST EL. = 586.68
LEVEE NO.1
TOP EL. VARIES
SIDE SLOPES 1 ON 2.5
WOODSVILLE
GEN
COM
NEW Y
LOCAL P
CAN
PLAN O
U.S. ARMY E

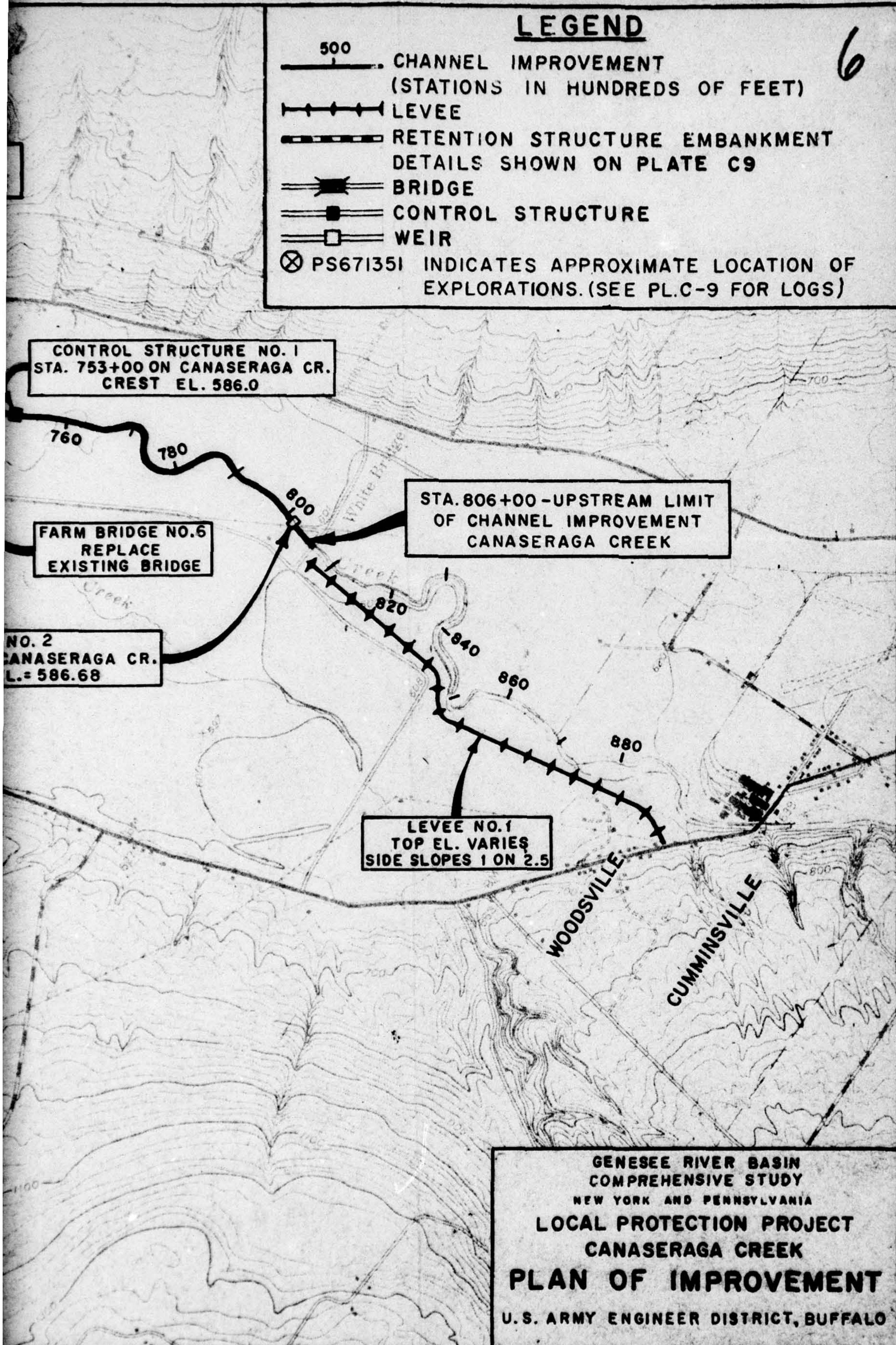
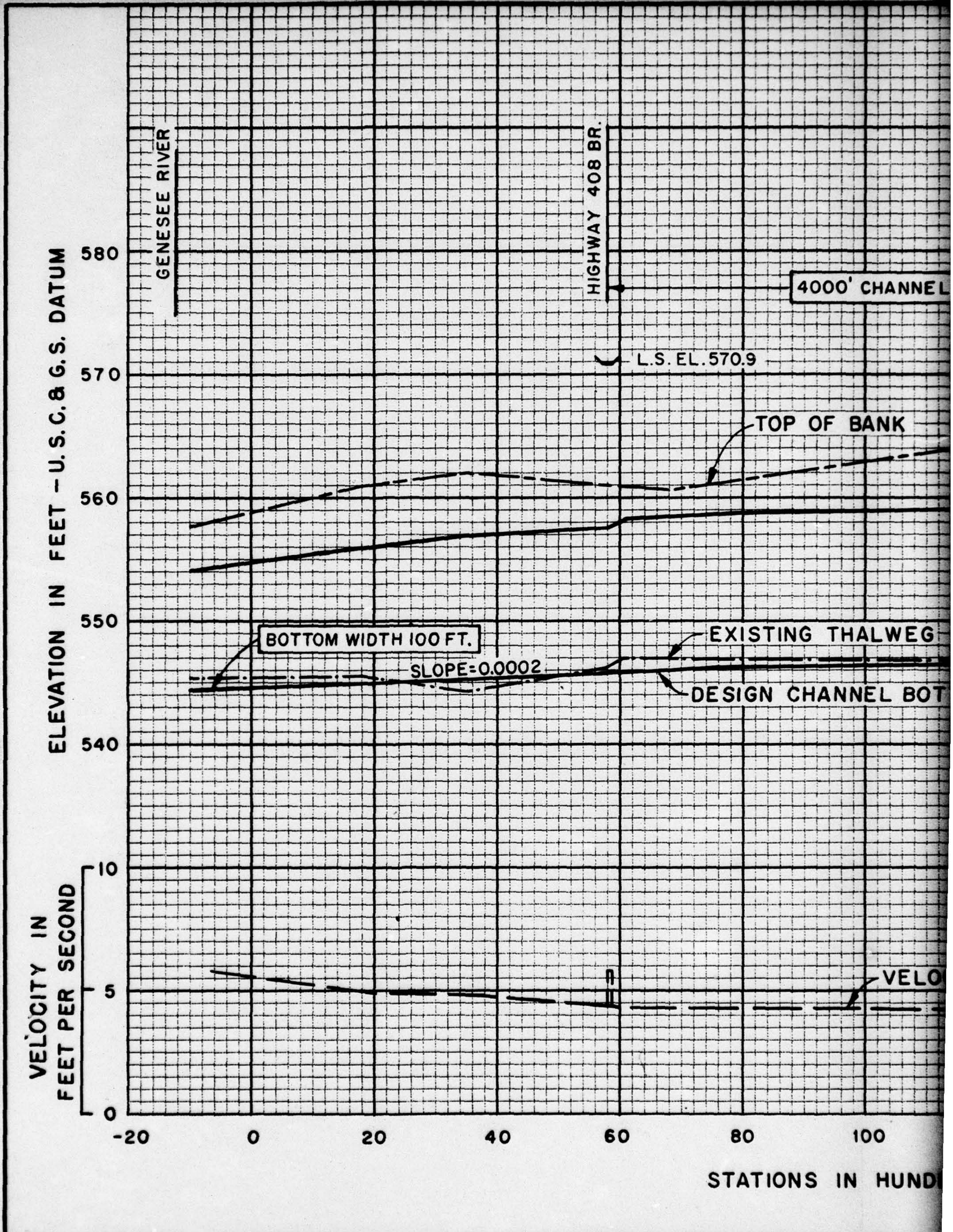
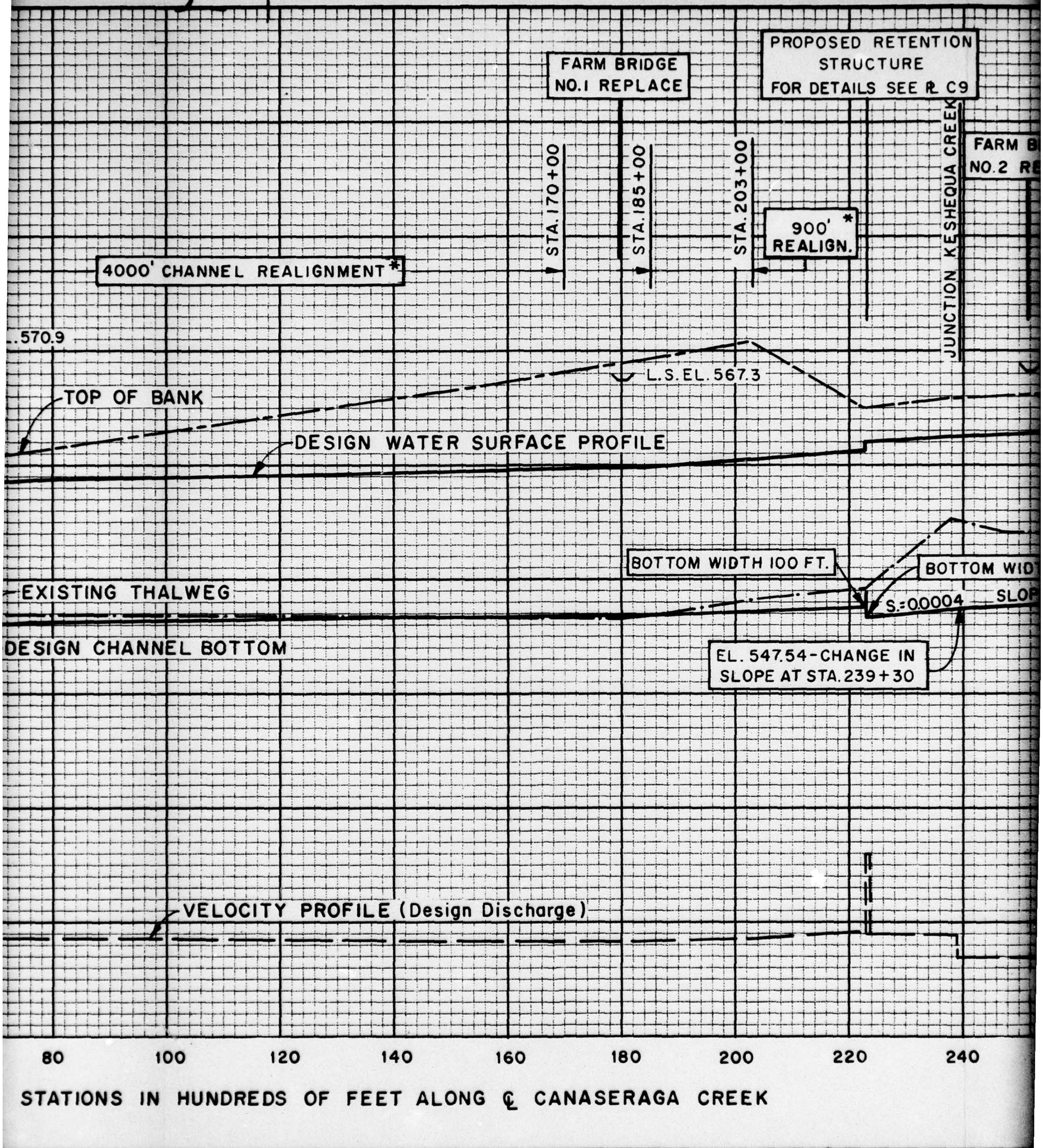
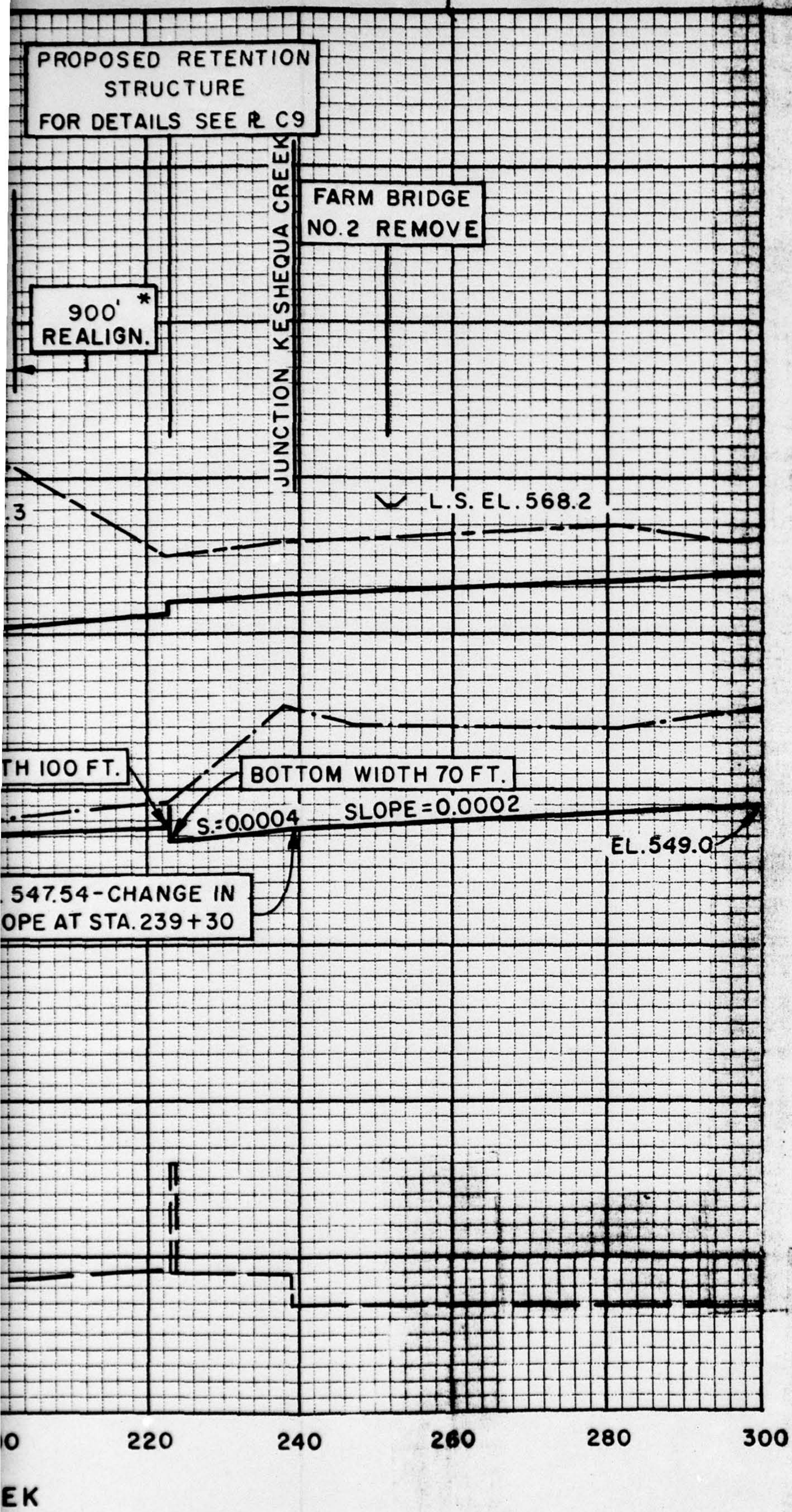

LEGEND
6
500
CHANNEL IMPROVEMENT
(STATIONS IN HUNDREDS OF FEET)
LEVEE
RETENTION STRUCTURE EMBANKMENT
DETAILS SHOWN ON PLATE C9
BRIDGE
CONTROL STRUCTURE
WEIR
PS671351 INDICATES APPROXIMATE LOCATION OF EXPLORATIONS. (SEE PL.C-9 FOR LOGS)
CONTROL STRUCTURE NO. 1
STA. 753+00 ON CANASERAGA CR.
CREST EL. 586.0
760
780
800
STA. 806+00 - UPSTREAM LIMIT
OF CHANNEL IMPROVEMENT
CANASERAGA CREEK
FARM BRIDGE NO.6
REPLACE
EXISTING BRIDGE
White Bridge
Creek
NO. 2
CANASERAGA CR.
L.= 586.68
820
840
860
880
LEVEE NO.1
TOP EL. VARIES
SIDE SLOPES 1 ON 2.5
WOODSVILLE
CUMMINSVILLE
700
800
1100
GENESEE RIVER BASIN
COMPREHENSIVE STUDY
NEW YORK AND PENNSYLVANIA
LOCAL PROTECTION PROJECT
CANASERAGA CREEK
PLAN OF IMPROVEMENT
U.S. ARMY ENGINEER DISTRICT, BUFFALO

PLATE C2


GENESEE RIVER
HIGHWAY 408 BR.
4000' CHANNEL
L.S. EL. 570.9
TOP OF BANK
BOTTOM WIDTH 100 FT.
SLOPE=0.0002
EXISTING THALWEG
DESIGN CHANNEL BOT
VELO
ELEVATION IN FEET - U.S.C.& G.S. DATUM
VELOCITY IN FEET PER SECOND
580
570
560
550
540
10
5
0
-20
0
20
40
60
80
100
STATIONS IN HUND



FARM BRIDGE
NO.1 REPLACE
PROPOSED RETENTION
STRUCTURE
FOR DETAILS SEE PL C9
FARM B
NO.2 RE
STA. 170+00
STA. 185+00
STA. 203+00
900' * REALIGN.
JUNCTION KESHEQUA CREEK
4000' CHANNEL REALIGNMENT*
.570.9
L.S. EL. 567.3
TOP OF BANK
DESIGN WATER SURFACE PROFILE
BOTTOM WIDTH 100 FT.
BOTTOM WID
EXISTING THALWEG
S.=0.0004
SLOP
DESIGN CHANNEL BOTTOM
EL. 547.54-CHANGE IN
SLOPE AT STA. 239+30
VELOCITY PROFILE (Design Discharge)
80
100
120
140
160
180
200
220
240
STATIONS IN HUNDREDS OF FEET ALONG ℄ CANASERAGA CREEK



LEGEND

FARM BRIDGE NO. 2 REMOVE — INDICATES PROPOSED IMPROVEMENTS.

NOTES

IMPROVED CHANNEL SIDE SLOPES TO BE 1 VERTICAL ON 2 1/2 HORIZONTAL.

DESIGN WATER SURFACE PROFILE IS BASED ON 5 YEAR "SUMMER EVENTS" FREQUENCY WITH MINIMUM GENESEE RIVER DISCHARGE AT JONES BRIDGE.

RIPRAPPED TRANSITIONS WOULD BE PROVIDED UPSTREAM OF BRIDGES.

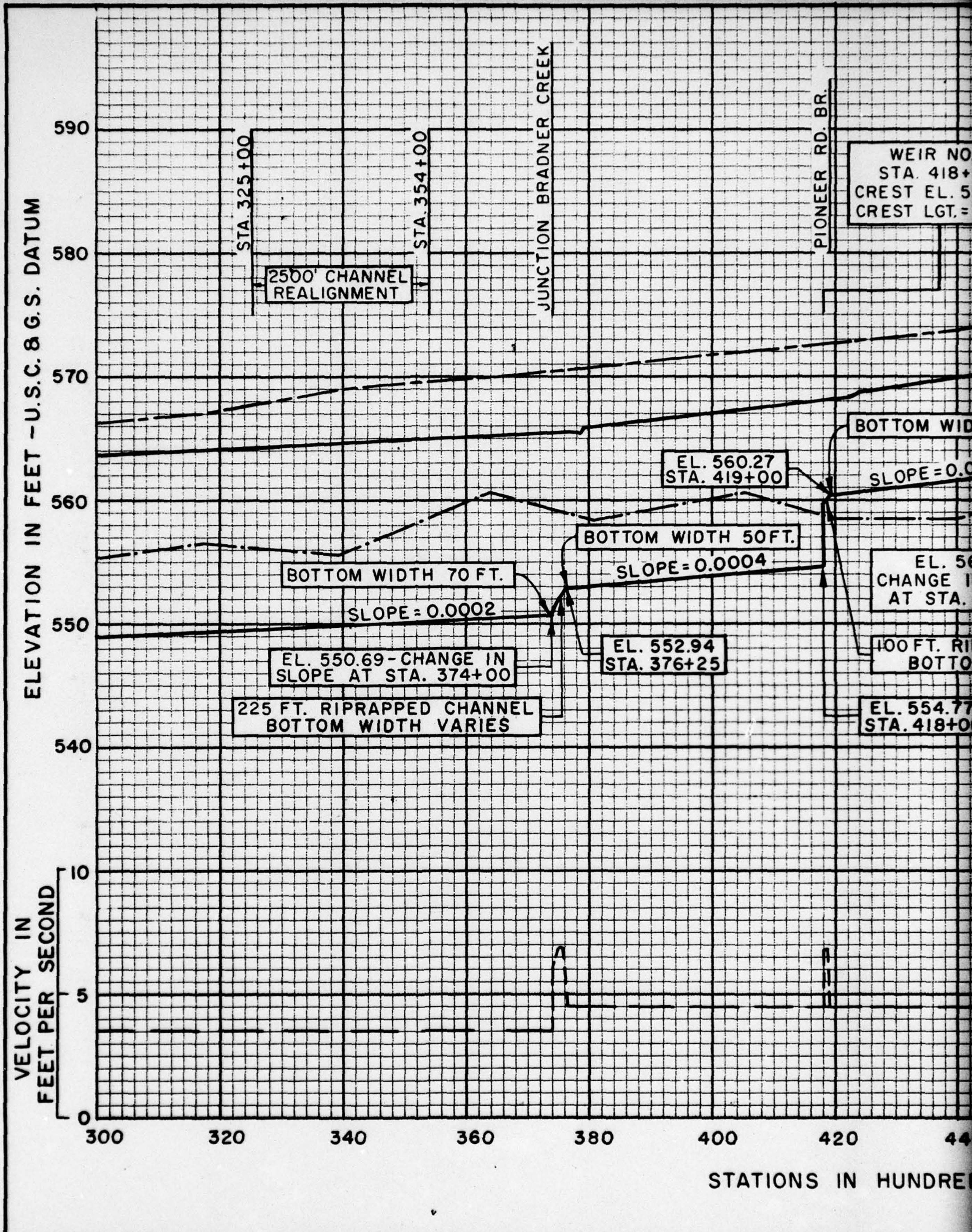
*SEE PLATE C2.

GENESEE RIVER BASIN
COMPREHENSIVE STUDY
NEW YORK AND PENNSYLVANIA

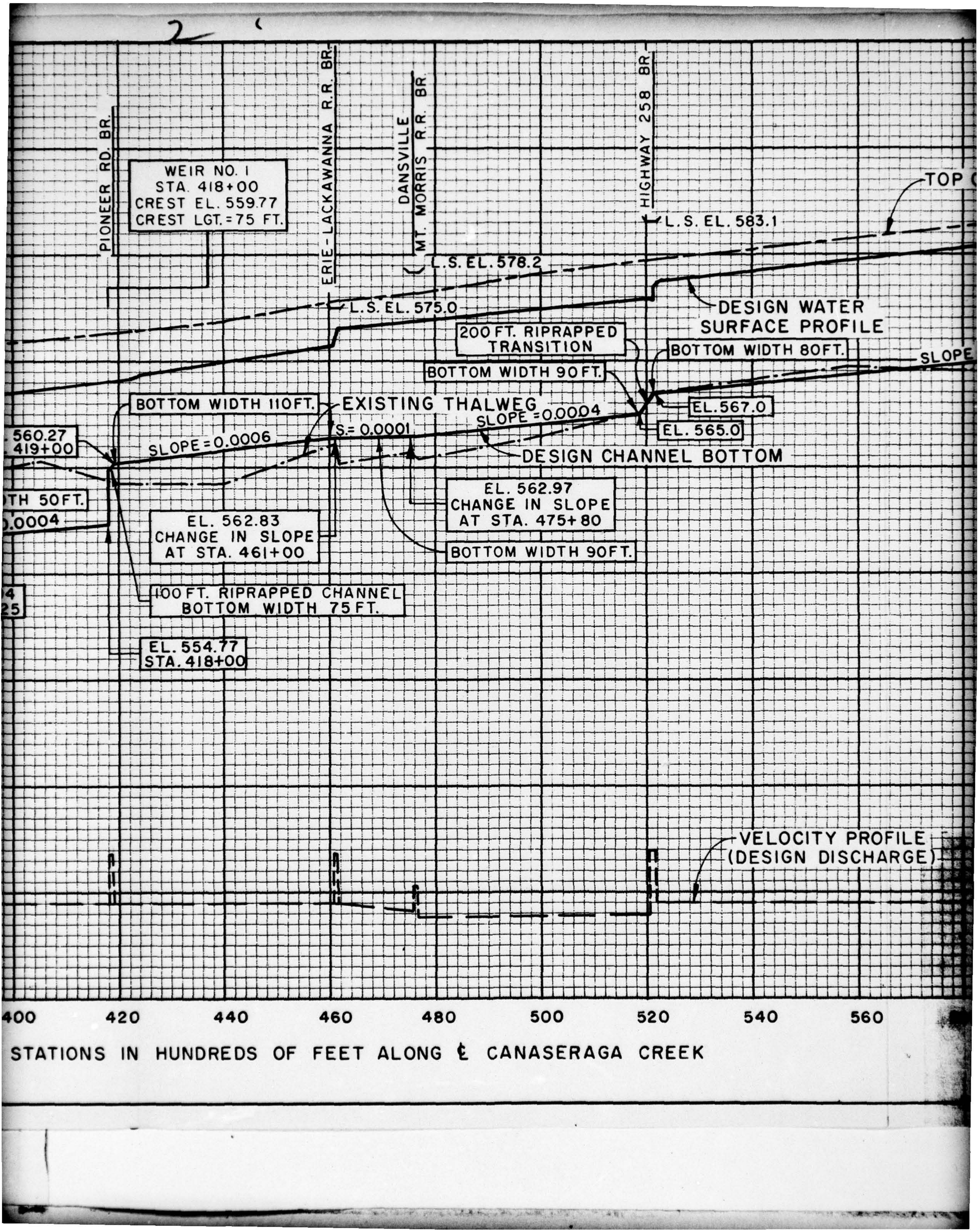
LOCAL PROTECTION PROJECT
CANASERAGA CREEK

PROFILES-10+00 TO 300+00

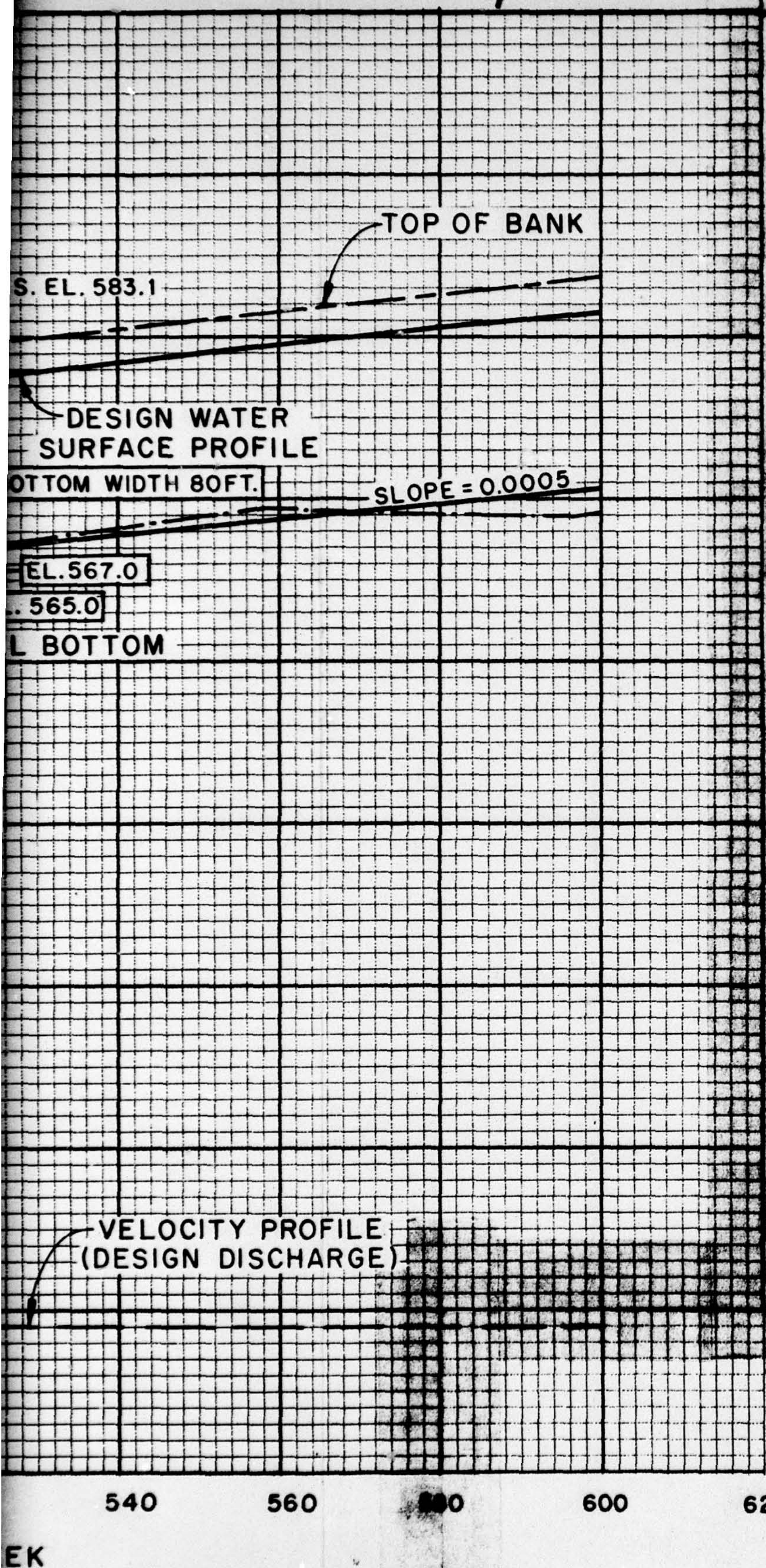
U. S. ARMY ENGINEER DISTRICT, BUFFALO



STA. 325+00
STA. 354+00
2500' CHANNEL REALIGNMENT
JUNCTION BRADNER CREEK
PIONEER RD. BR.
WEIR NO.
STA. 418+0
CREST EL. 55
CREST LGT. = 7
BOTTOM WIDT
EL. 560.27
STA. 419+00
SLOPE = 0.00
BOTTOM WIDTH 50 FT.
BOTTOM WIDTH 70 FT.
SLOPE = 0.0004
EL. 56
CHANGE IN
AT STA. 4
SLOPE = 0.0002
EL. 552.94
STA. 376+25
100 FT. RIP
BOTTON
EL. 550.69 - CHANGE IN SLOPE AT STA. 374+00
225 FT. RIPRAPPED CHANNEL BOTTOM WIDTH VARIES
EL. 554.77
STA. 418+00
ELEVATION IN FEET - U.S.C. & G.S. DATUM
VELOCITY IN FEET PER SECOND
590
580
570
560
550
540
10
5
0
300
320
340
360
380
400
420
44
STATIONS IN HUNDRED


2
PIONEER RD. BR.
WEIR NO. 1
STA. 418+00
CREST EL. 559.77
CREST LGT. = 75 FT.
ERIE-LACKAWANNA R.R. BR.
DANSVILLE
MT. MORRIS R.R. BR.
HIGHWAY 258 BR.
TOP O
L.S. EL. 583.1
L.S. EL. 578.2
L.S. EL. 575.0
DESIGN WATER SURFACE PROFILE
200 FT. RIPRAPPED TRANSITION
BOTTOM WIDTH 80 FT.
SLOPE
BOTTOM WIDTH 90 FT.
EL. 567.0
EL. 565.0
BOTTOM WIDTH 110 FT.
EXISTING THALWEG
SLOPE = 0.0004
560.27
419+00
SLOPE = 0.0006
S. = 0.0001
DESIGN CHANNEL BOTTOM
TH 50 FT.
.0004
EL. 562.97
CHANGE IN SLOPE
AT STA. 475+80
EL. 562.83
CHANGE IN SLOPE
AT STA. 461+00
BOTTOM WIDTH 90 FT.
4
25
100 FT. RIPRAPPED CHANNEL
BOTTOM WIDTH 75 FT.
EL. 554.77
STA. 418+00
VELOCITY PROFILE
(DESIGN DISCHARGE)
400
420
440
460
480
500
520
540
560
STATIONS IN HUNDREDS OF FEET ALONG ℄ CANASERAGA CREEK

3



LEGEND:

WEIR NO. 1 STA. 418+00 CREST EL. 559.77	INDICATES PROPOSED IMPROVEMENTS

NOTES:

IMPROVED CHANNEL SIDE SLOPES TO BE 1 VERTICAL ON 2 1/2 HORIZONTAL.

DESIGN WATER SURFACE PROFILE IS BASED ON 5-YEAR "SUMMER EVENTS" FREQUENCY WITH MINIMUM GENESEE RIVER DISCHARGE AT JONES BRIDGE.

RIPRAPPED TRANSITIONS WOULD BE PROVIDED UPSTREAM AND DOWNSTREAM OF BRIDGES AND WEIRS.

GENESEE RIVER BASIN
COMPREHENSIVE STUDY

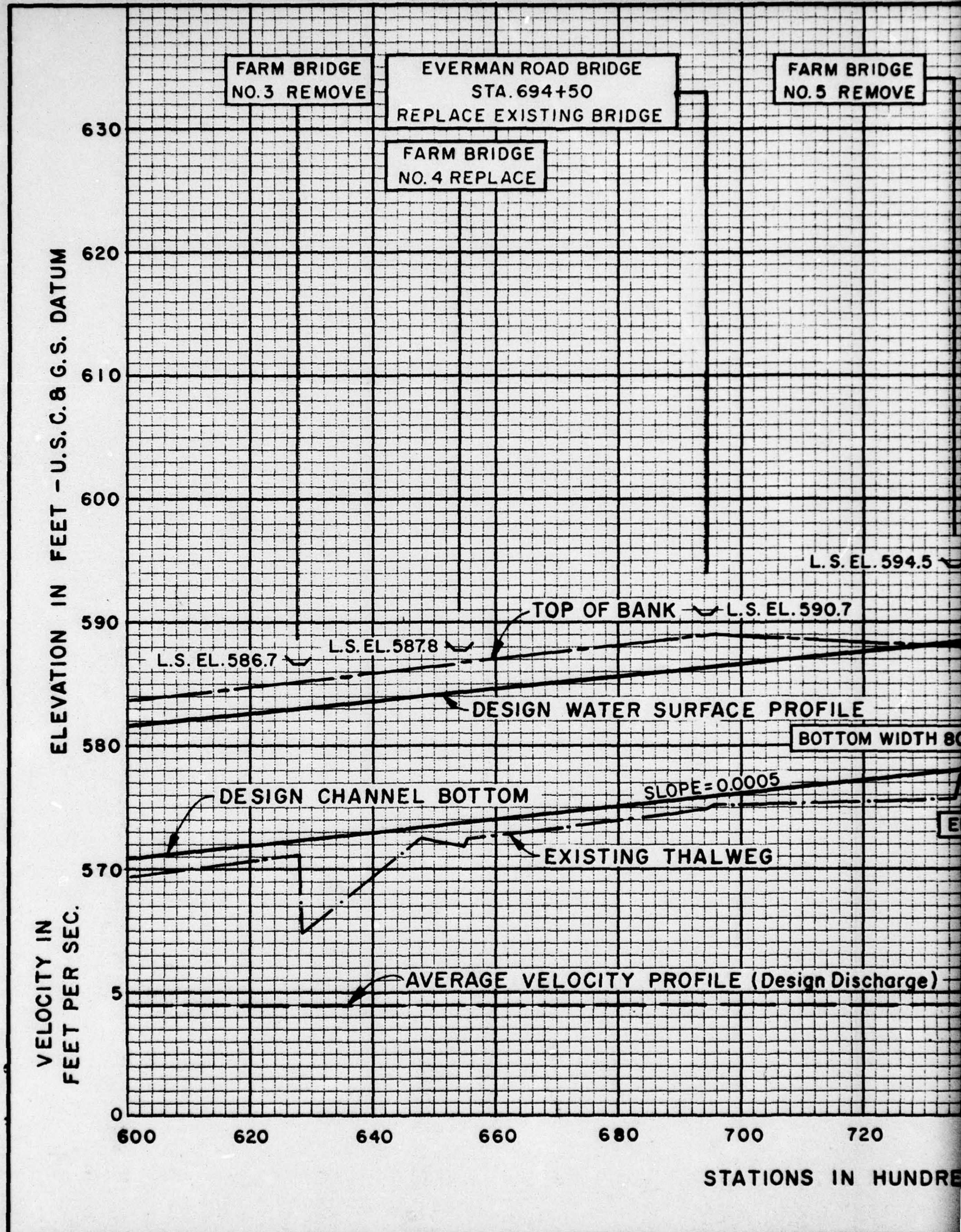
NEW YORK AND PENNSYLVANIA

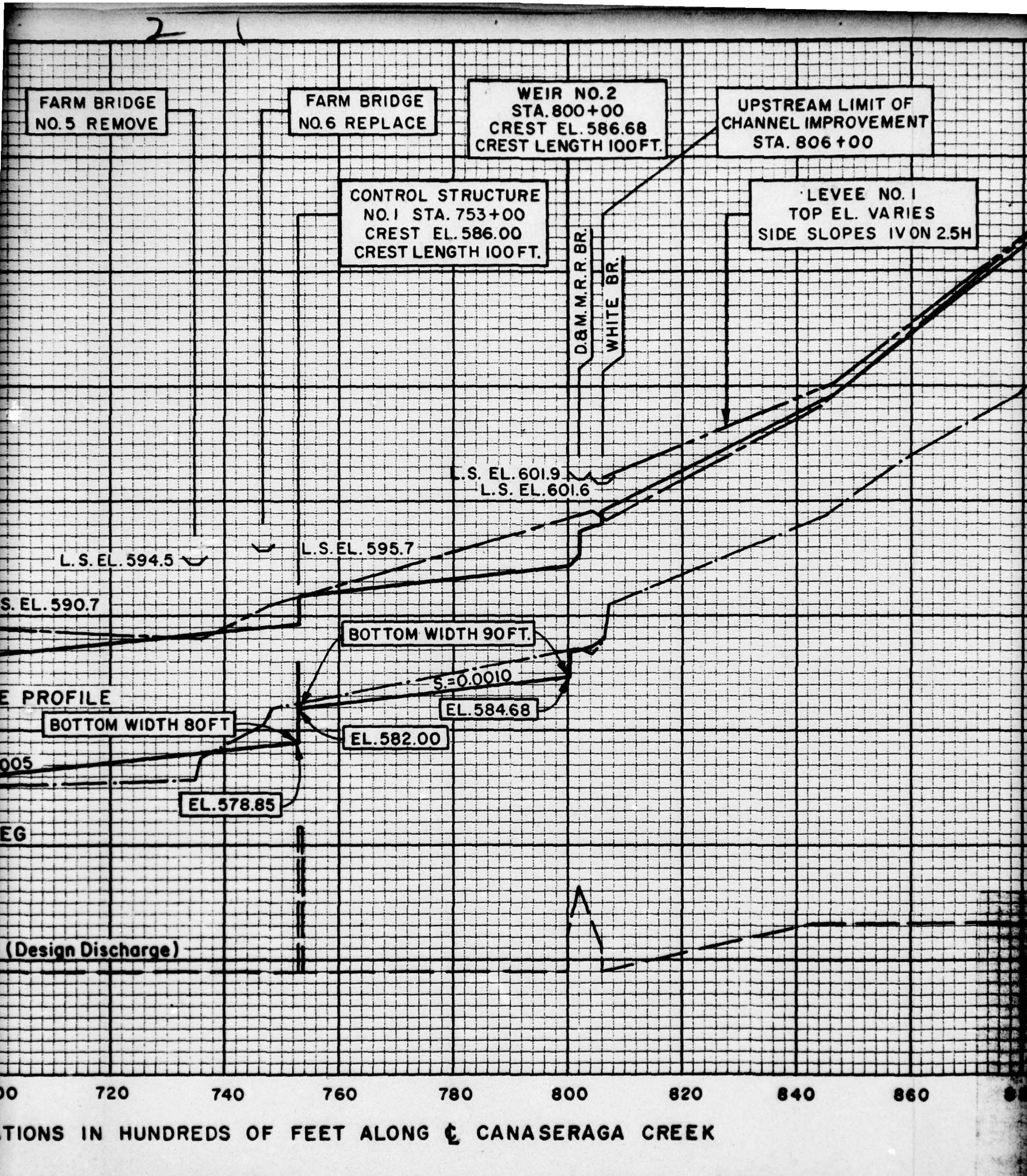
LOCAL PROTECTION PROJECT
CANASERAGA CREEK

PROFILES 300+00 TO 600+00

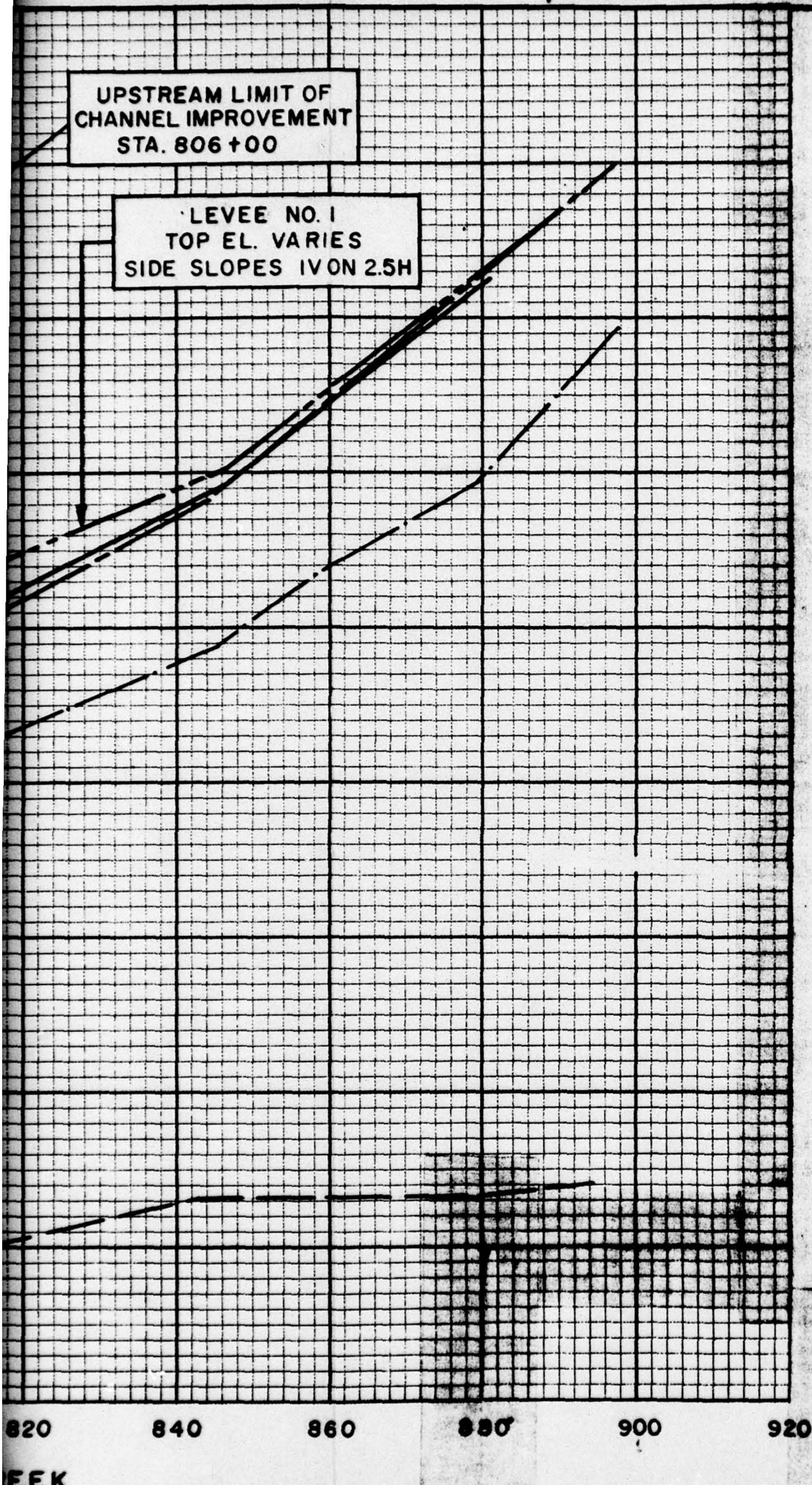
U. S. ARMY ENGINEER DISTRICT, BUFFALO

PLATE C4


FARM BRIDGE NO.3 REMOVE
EVERMAN ROAD BRIDGE STA. 694+50 REPLACE EXISTING BRIDGE
FARM BRIDGE NO.4 REPLACE
FARM BRIDGE NO.5 REMOVE
L. S. EL. 594.5
TOP OF BANK
L.S. EL. 590.7
L.S. EL. 587.8
L.S. EL. 586.7
DESIGN WATER SURFACE PROFILE
BOTTOM WIDTH 80
SLOPE = 0.0005
DESIGN CHANNEL BOTTOM
EXISTING THALWEG
AVERAGE VELOCITY PROFILE (Design Discharge)
ELEVATION IN FEET - U.S.C.&G.S. DATUM
VELOCITY IN FEET PER SEC.
630
620
610
600
590
580
570
5
0
600
620
640
660
680
700
720
STATIONS IN HUNDRE



2
FARM BRIDGE NO. 5 REMOVE
FARM BRIDGE NO. 6 REPLACE
WEIR NO. 2 STA. 800+00 CREST EL. 586.68 CREST LENGTH 100 FT.
UPSTREAM LIMIT OF CHANNEL IMPROVEMENT STA. 806+00
CONTROL STRUCTURE NO. 1 STA. 753+00 CREST EL. 586.00 CREST LENGTH 100 FT.
LEVEE NO. 1 TOP EL. VARIES SIDE SLOPES 1V ON 2.5H
D.&M.M.R.R. BR.
WHITE BR.
L.S. EL. 601.9
L.S. EL. 601.6
L.S. EL. 594.5
L.S. EL. 595.7
.S. EL. 590.7
BOTTOM WIDTH 90 FT.
S.=0.0010
EL. 584.68
E PROFILE
BOTTOM WIDTH 80 FT
EL. 582.00
0005
EL. 578.85
WEG
E (Design Discharge)
00
720
740
760
780
800
820
840
860
8
ATIONS IN HUNDREDS OF FEET ALONG ℄ CANASERAGA CREEK



3

LEGEND

LEVEE NO. I
TOP EL. VARIES
SIDE SLOPES IV ON 2.5H

INDICATES PROPOSED IMPROVEMENTS

NOTES

IMPROVED CHANNEL SIDE SLOPES TO BE I VERTICAL ON 2 1/2 HORIZONTAL.

DESIGN WATER SURFACE PROFILE IS BASED ON 5 YEAR "SUMMER EVENTS" FREQUENCY WITH MINIMUM GENESEE RIVER DISCHARGE AT JONES BRIDGE.

RIPRAPPED TRANSITIONS WOULD BE PROVIDED UPSTREAM AND DOWNSTREAM OF BRIDGES AND WEIRS.

TOP OF BANK DENOTES TOP OF LOW BANK AT THE GIVEN STATION.

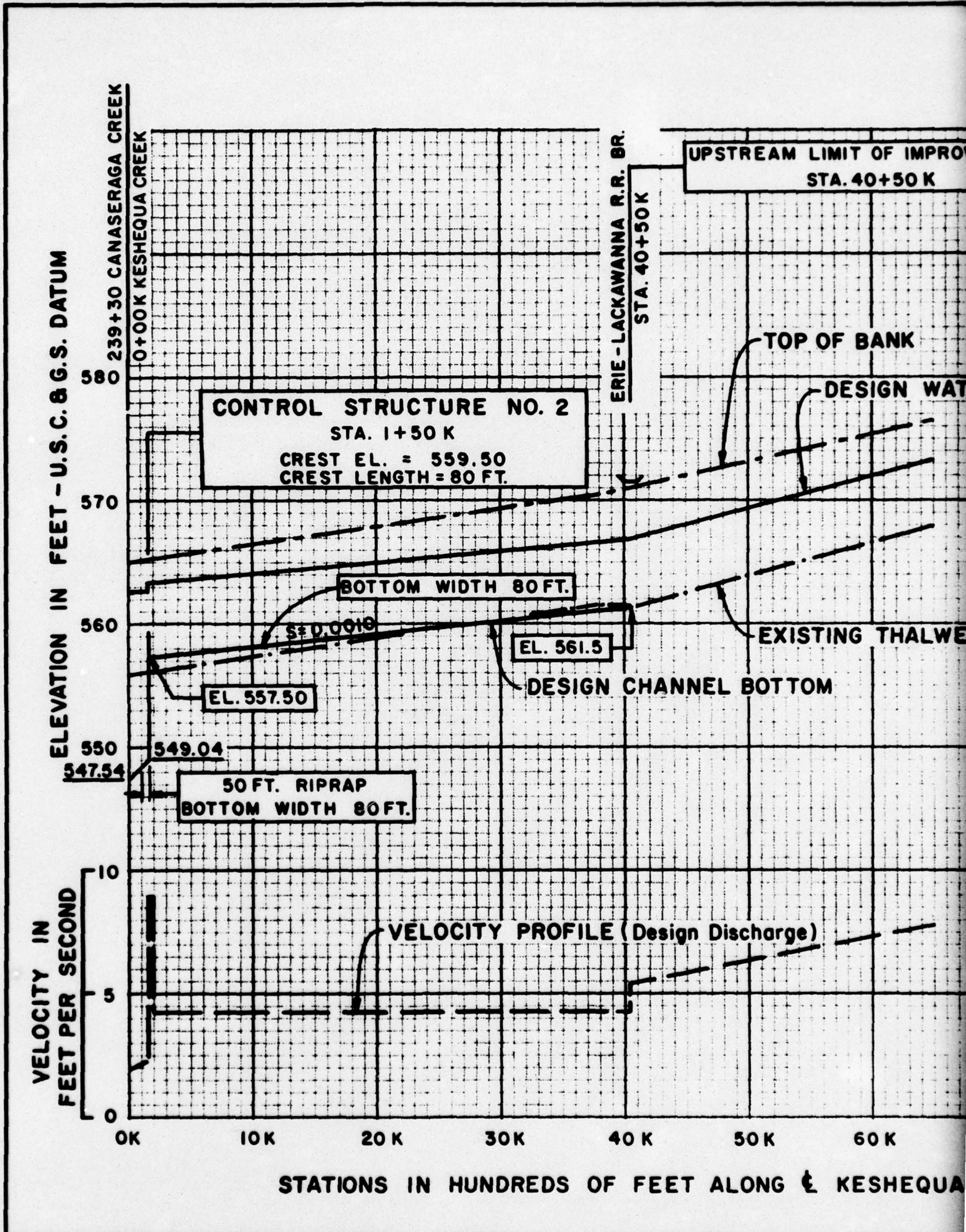
GENESEE RIVER BASIN
COMPREHENSIVE STUDY
NEW YORK AND PENNSYLVANIA

LOCAL PROTECTION PROJECT
CANASERAGA CREEK

PROFILES 600+00 TO 898+00

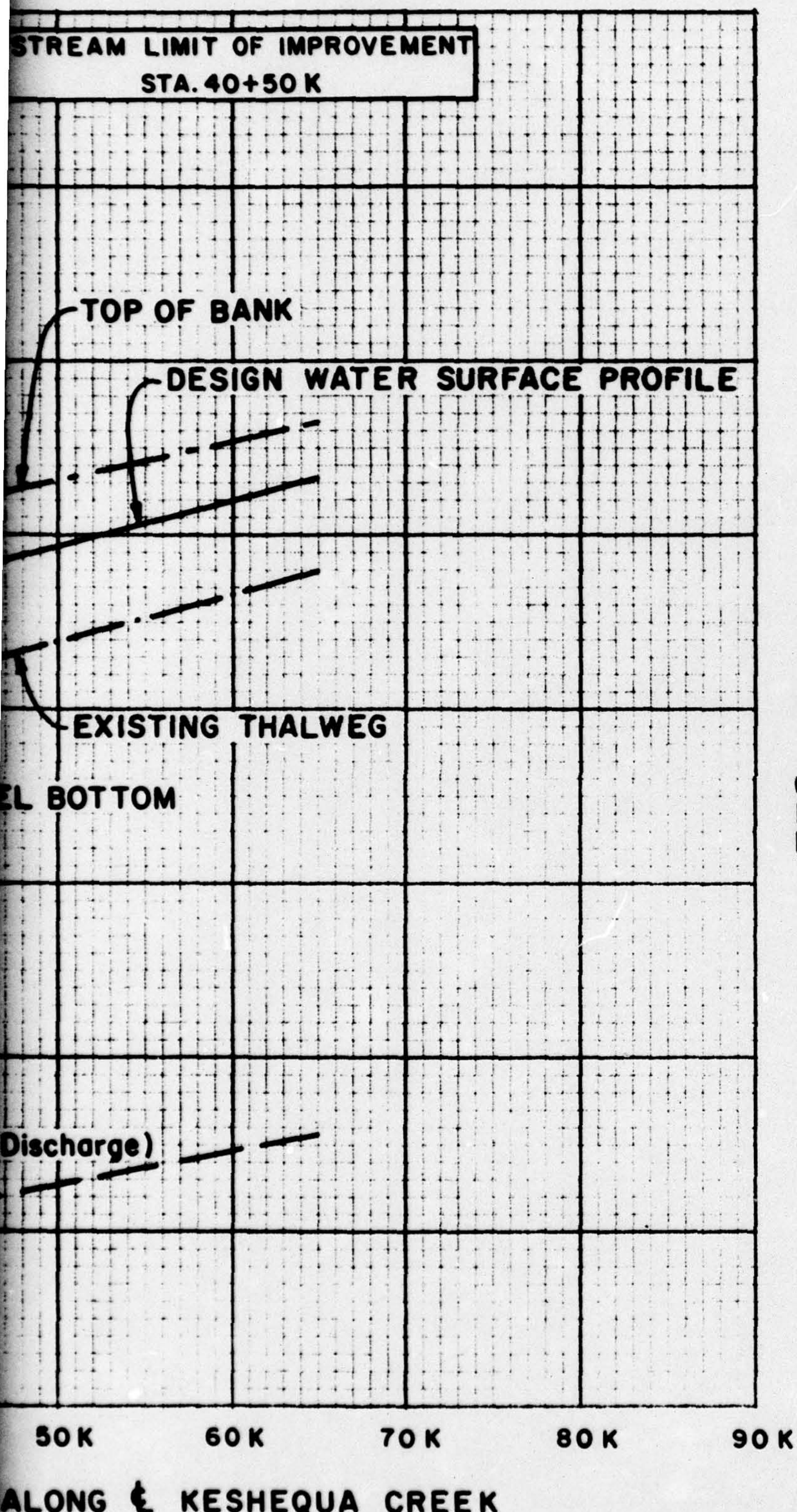
U. S. ARMY ENGINEER DISTRICT, BUFFALO

PLATE C5



239+30 CANASERAGA CREEK
0+00K KESHEQUA CREEK
ERIE-LACKAWANNA R.R. BR.
STA. 40+50K
UPSTREAM LIMIT OF IMPROV
STA. 40+50 K
TOP OF BANK
DESIGN WAT
CONTROL STRUCTURE NO. 2
STA. 1+50 K
CREST EL. = 559.50
CREST LENGTH = 80 FT.
BOTTOM WIDTH 80 FT.
S=0.0010
EL. 561.5
EXISTING THALWE
DESIGN CHANNEL BOTTOM
EL. 557.50
549.04
547.54
50 FT. RIPRAP
BOTTOM WIDTH 80 FT.
ELEVATION IN FEET - U.S.C. & G.S. DATUM
580
570
560
550
VELOCITY IN FEET PER SECOND
10
5
0
VELOCITY PROFILE (Design Discharge)
0K
10K
20K
30K
40K
50K
60K
STATIONS IN HUNDREDS OF FEET ALONG ℄ KESHEQUA

2



LEGEND

CONTROL STRUCTURE NO. 2 STA. 1+50 K CREST EL. = 559.50 CREST LENGTH = 80 FT.	INDICATES PROPOSED IMPROVEMENTS.

NOTES

IMPROVED CHANNEL SIDE SLOPES TO BE 1 VERTICAL ON 2 1/2 HORIZONTAL.

DESIGN WATER SURFACE PROFILE ON KESHEQUA CREEK IS BASED ON MAXIMUM 5 YEAR "SUMMER EVENTS" STAGE ON CANASERAGA CREEK AND CORRESPONDING DISCHARGE ON KESHEQUA CREEK.

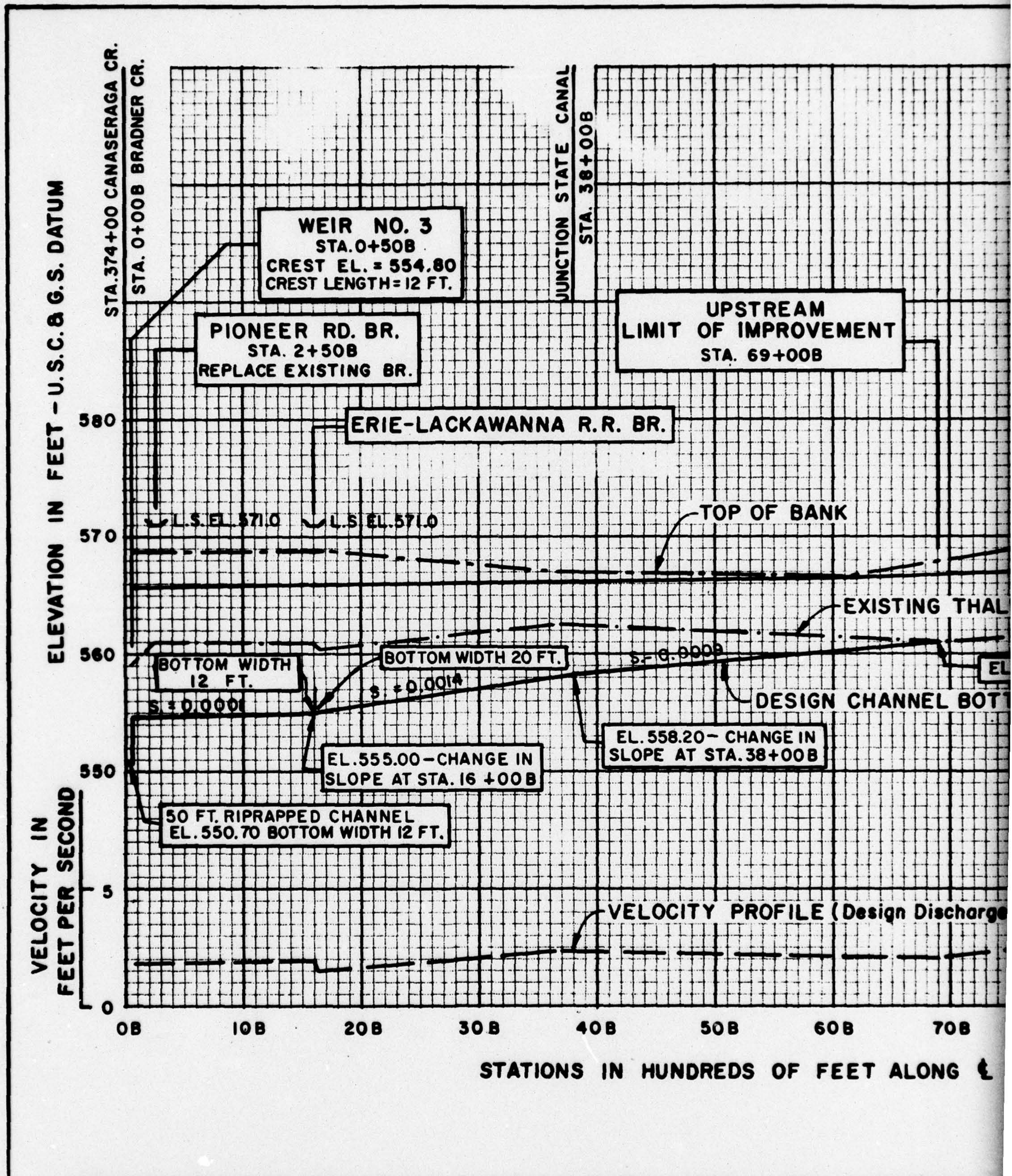
TOP OF BANK DENOTES TOP OF LOW BANK AT THE GIVEN STATION.

GENESEE RIVER BASIN
COMPREHENSIVE STUDY
NEW YORK AND PENNSYLVANIA

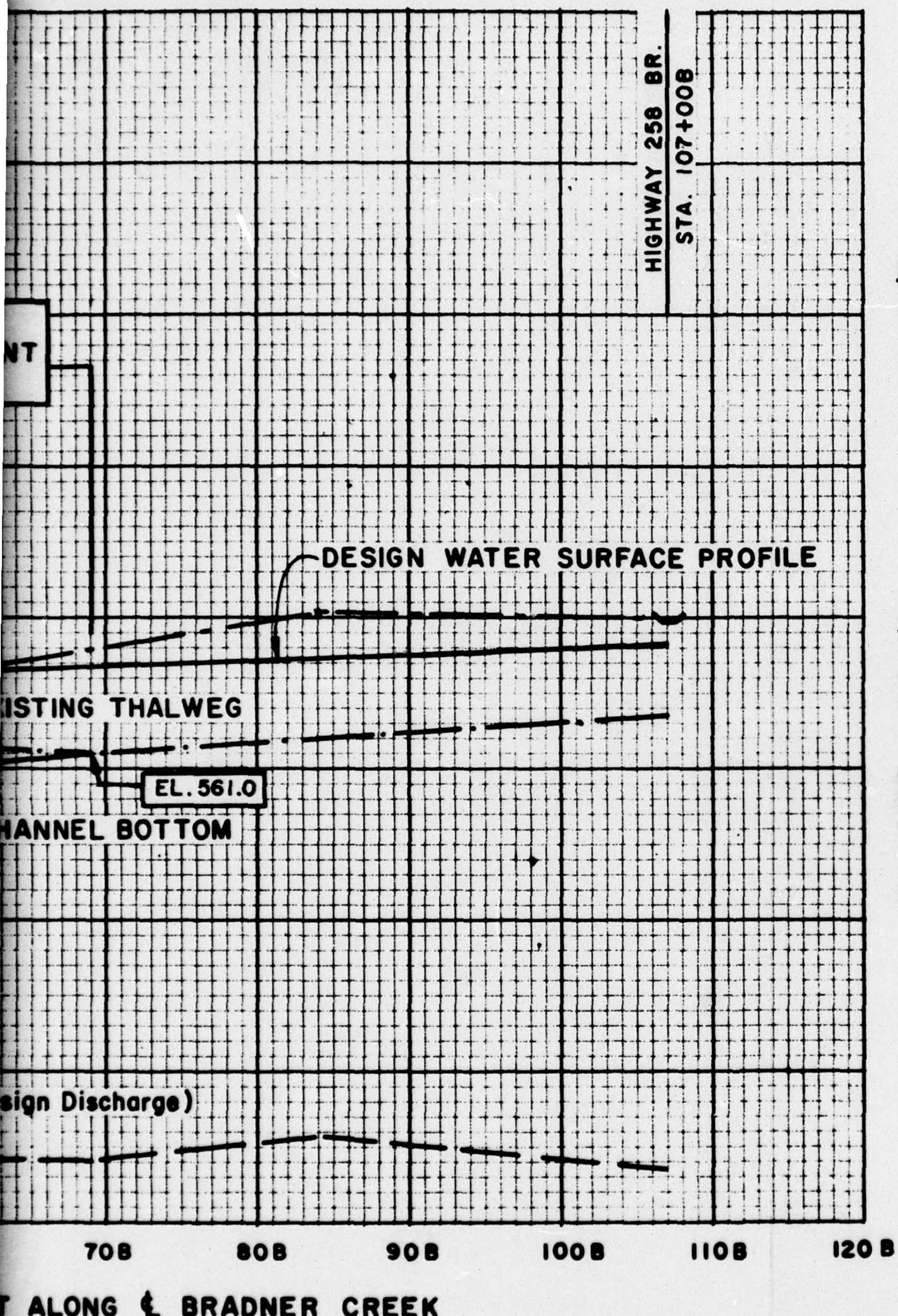
LOCAL PROTECTION PROJECT
CANASERAGA CREEK

KESHEQUA CREEK PROFILE

U. S. ARMY ENGINEER DISTRICT, BUFFALO



STA.374+00 CANASERAGA CR.
STA. 0+00B BRADNER CR.
JUNCTION STATE CANAL
STA. 38+00B
WEIR NO. 3
STA.0+50B
CREST EL. = 554.80
CREST LENGTH = 12 FT.
PIONEER RD. BR.
STA. 2+50B
REPLACE EXISTING BR.
UPSTREAM
LIMIT OF IMPROVEMENT
STA. 69+00B
ERIE-LACKAWANNA R.R. BR.
L.S. EL. 571.0
L.S. EL. 571.0
TOP OF BANK
EXISTING THAL
BOTTOM WIDTH 12 FT.
BOTTOM WIDTH 20 FT.
S = 0.0009
S = 0.0014
S = 0.0001
EL
DESIGN CHANNEL BOTT
EL. 558.20 - CHANGE IN SLOPE AT STA. 38+00B
EL. 555.00 - CHANGE IN SLOPE AT STA. 16+00B
50 FT. RIPRAPPED CHANNEL
EL. 550.70 BOTTOM WIDTH 12 FT.
VELOCITY PROFILE (Design Discharge
ELEVATION IN FEET - U.S.C. & G.S. DATUM
580
570
560
550
VELOCITY IN FEET PER SECOND
5
0
0B
10B
20B
30B
40B
50B
60B
70B
STATIONS IN HUNDREDS OF FEET ALONG ℄



LEGEND

WEIR NO. 3
STA. 0+50 B
CREST EL. 554.80
CREST LGT. = 12 FT.

INDICATES PROPOSED IMPROVEMENTS.

NOTES

IMPROVED CHANNEL SIDE SLOPES TO BE 1 VERTICAL ON 2 1/2 HORIZONTAL.

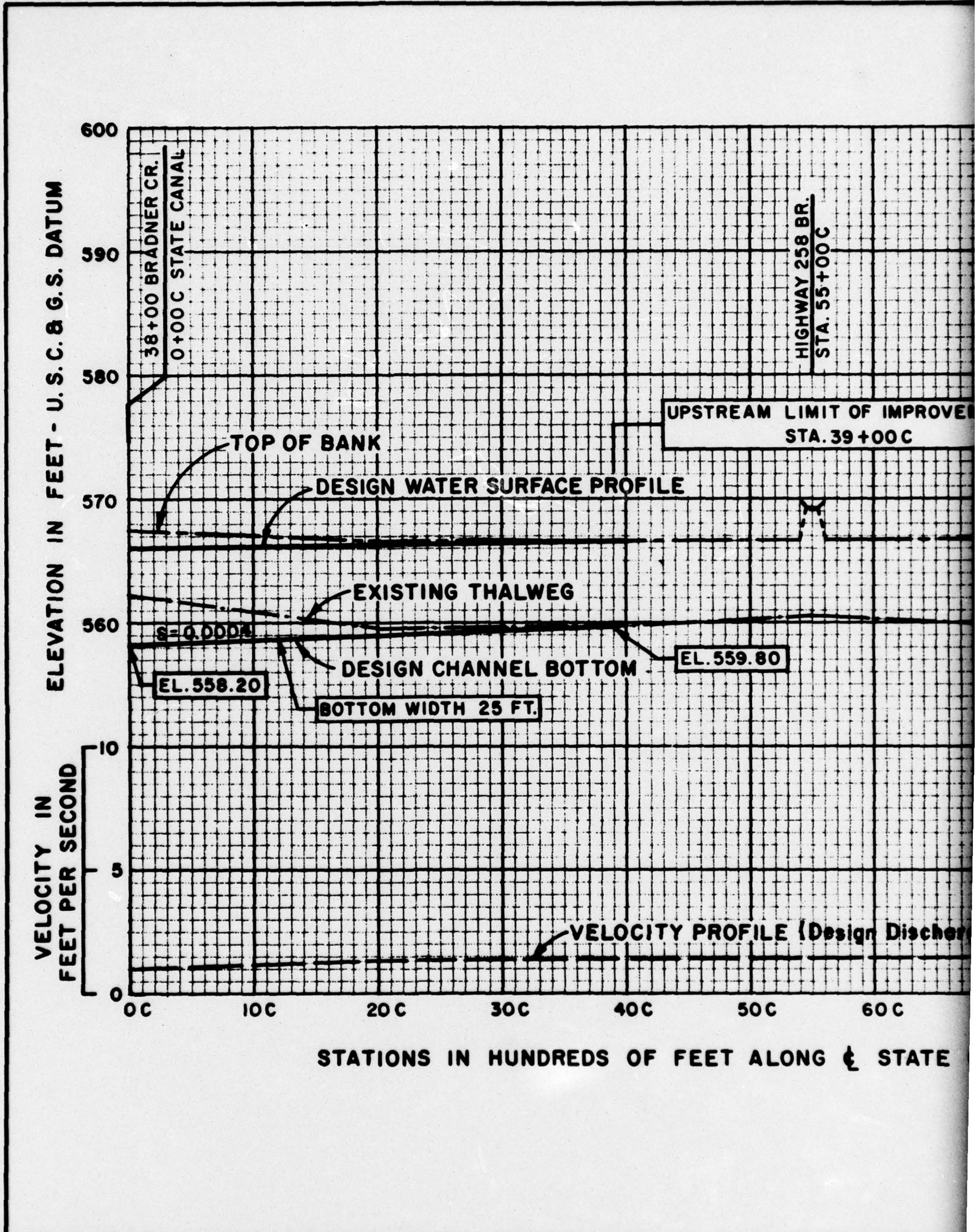
DESIGN WATER SURFACE PROFILE ON BRADNER CREEK IS BASED ON MAXIMUM 5 YEAR "SUMMER EVENTS" STAGE ON CANASERAGA CREEK.

TOP OF BANK DENOTES TOP OF LOW BANK AT THE GIVEN STATION.

GENESEE RIVER BASIN
COMPREHENSIVE STUDY
NEW YORK AND PENNSYLVANIA
LOCAL PROTECTION PROJECT
CANASERAGA CREEK

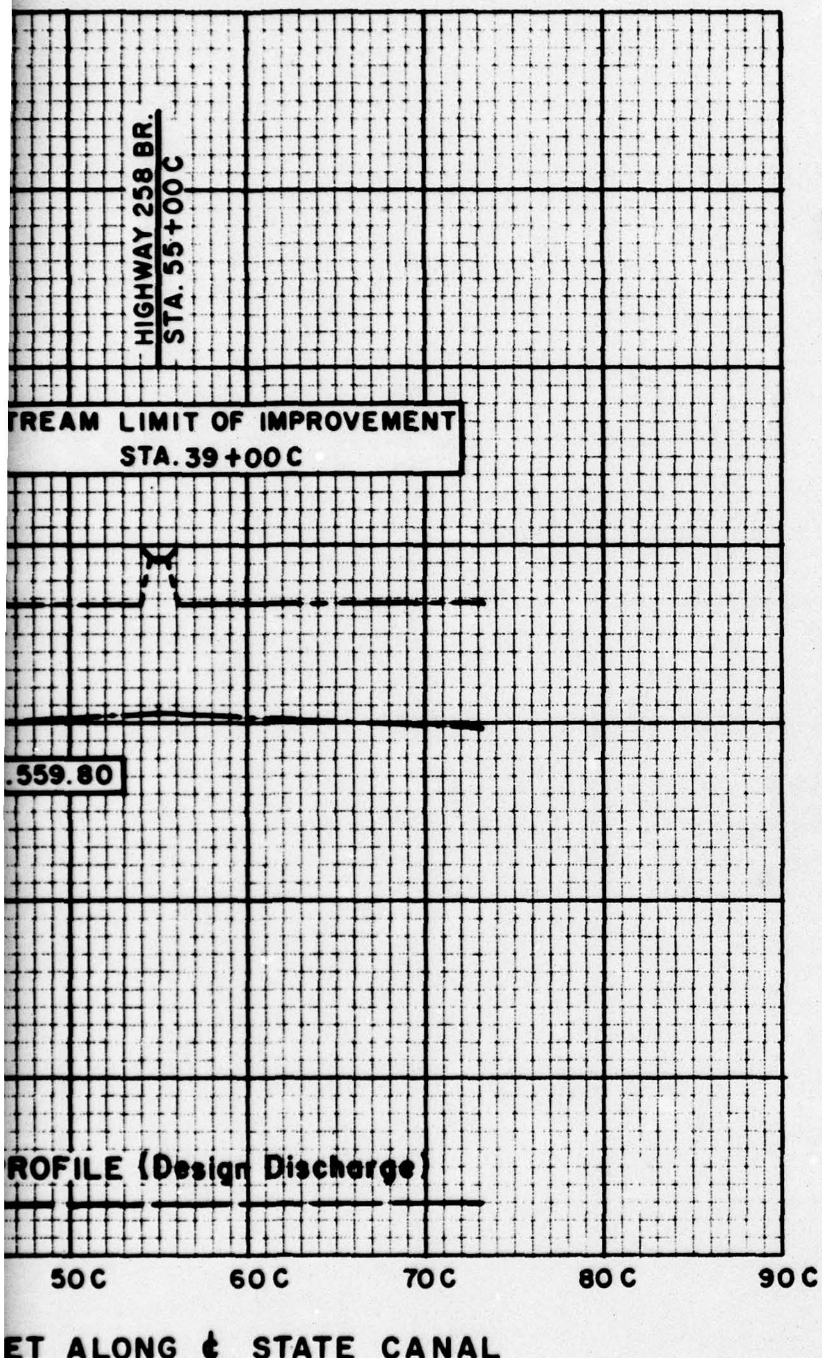
BRADNER CREEK PROFILE

U. S. ARMY ENGINEER DISTRICT, BUFFALO



ELEVATION IN FEET - U.S.C.&G.S. DATUM
600
590
580
570
560
38+00 BRADNER CR.
0+00C STATE CANAL
HIGHWAY 258 BR.
STA. 55+00C
UPSTREAM LIMIT OF IMPROVE
STA. 39+00C
TOP OF BANK
DESIGN WATER SURFACE PROFILE
EXISTING THALWEG
S=0.0004
DESIGN CHANNEL BOTTOM
EL. 559.80
EL. 558.20
BOTTOM WIDTH 25 FT.
VELOCITY IN FEET PER SECOND
10
5
0
VELOCITY PROFILE (Design Discharg
0C
10C
20C
30C
40C
50C
60C
STATIONS IN HUNDREDS OF FEET ALONG ℄ STATE

2



LEGEND

BOTTOM WIDTH 25 FT. INDICATES PROPOSED IMPROVEMENTS.

NOTES

IMPROVED CHANNEL SIDE SLOPES TO BE 1 VERTICAL ON 2 1/2 HORIZONTAL.

DESIGN WATER SURFACE PROFILE ON STATE CANAL IS BASED ON MAXIMUM 5 YEAR "SUMMER EVENTS" STAGE ON BRADNER CREEK.

TOP OF BANK DENOTES TOP OF LOW BANK AT THE GIVEN STATION.

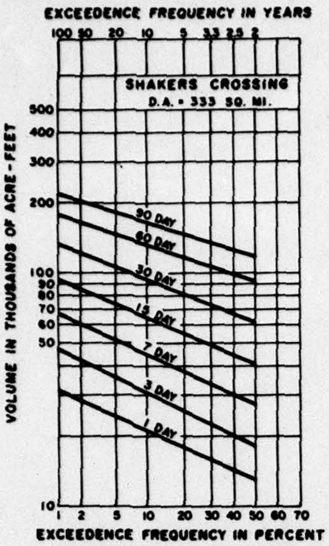
GENESEE RIVER BASIN
COMPREHENSIVE STUDY
NEW YORK AND PENNSYLVANIA

LOCAL PROTECTION PROJECT
CANASERAGA CREEK

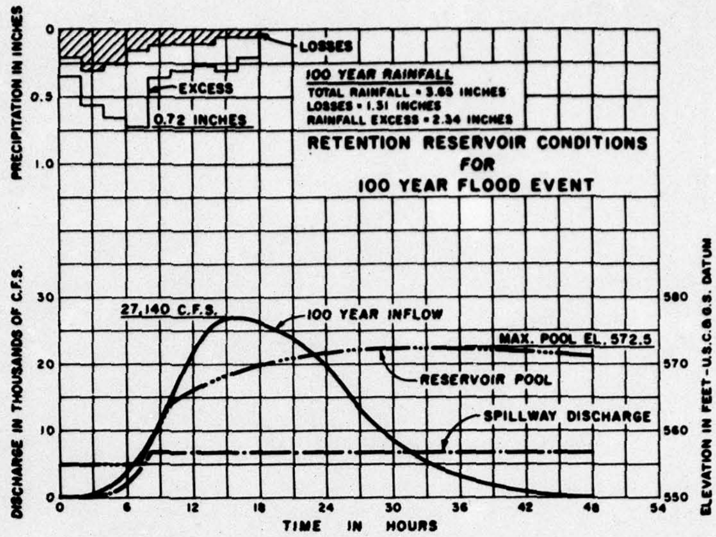
STATE CANAL PROFILE

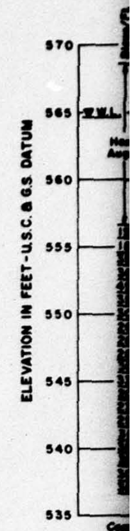
U. S. ARMY ENGINEER DISTRICT, BUFFALO

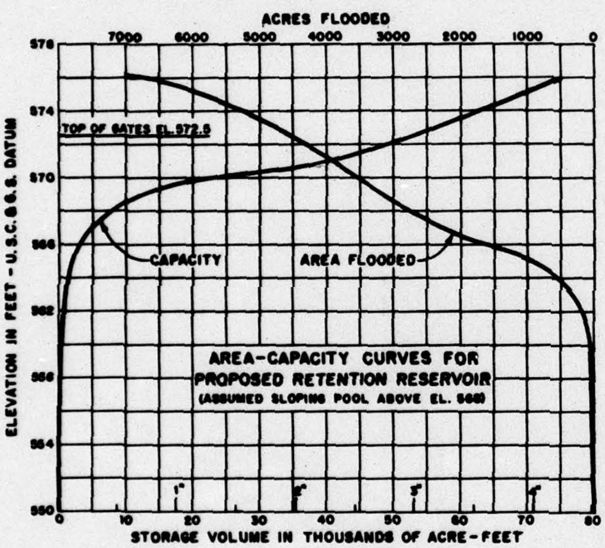
PLATE C

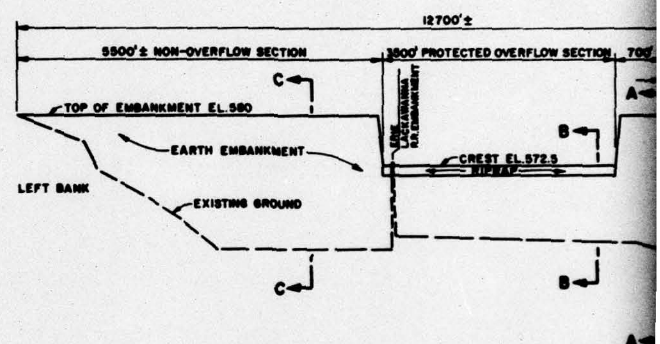


ANNUAL MAXIMUM FLOOD VOLUME FREQUENCY CURVES





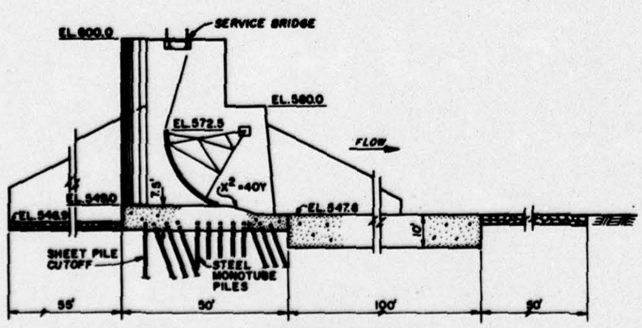




PROFILE ON AXIS OF RETENTION STRUCTURE

SCALE OF FEET (Horizontal)

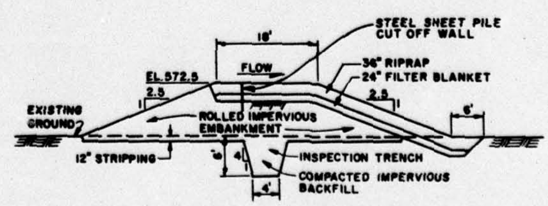
SCALE OF FEET (Vertical)



SECTION A-A

75' SPILLWAY SECTION

NOT TO SCALE

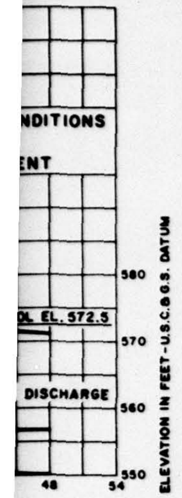


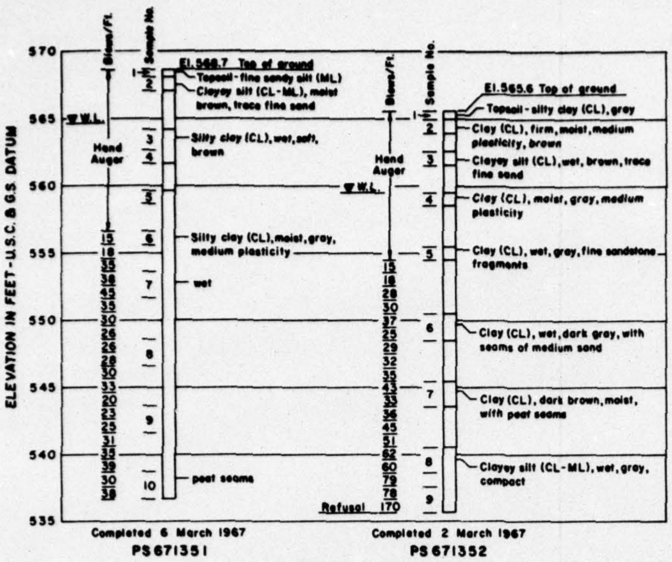
SECTION B-B

3500' OVERFLOW SECTION

NOT TO SCALE

2





LEGEND: (Subsurface Explorations)

▼W.L.	WATER LEVEL IN HOLE AT DATE OF COMPLETION
ML	SILT, INORGANIC, LOW TO NO PLASTICITY
CL	CLAY, INORGANIC, LOW TO MEDIUM PLASTICITY
CL-ML	BORDERLINE BETWEEN SILT AND CLAY

NOTES: (Subsurface Explorations)

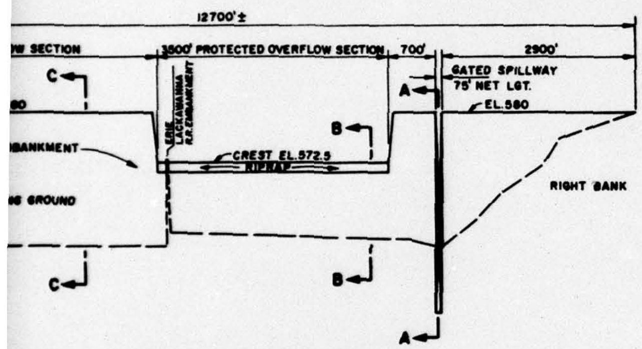
APPROXIMATE LOCATIONS OF HOLES ARE SHOWN ON PLATE C2

AUGER SAMPLES WERE OBTAINED WITH A 1 1/2" SPIRAL HAND AUGER.

BLOWS PER FOOT INDICATE THE EFFORT REQUIRED TO ADVANCE A 1 INCH PORTER SAMPLER BY MEANS OF A 25 LB. WEIGHT DROPPED 18" (APPROX.) AND MANUALLY OPERATED.

SOIL DESCRIPTIONS ARE BASED ON VISUAL AND MANUAL EXAMINATION OF SAMPLES.

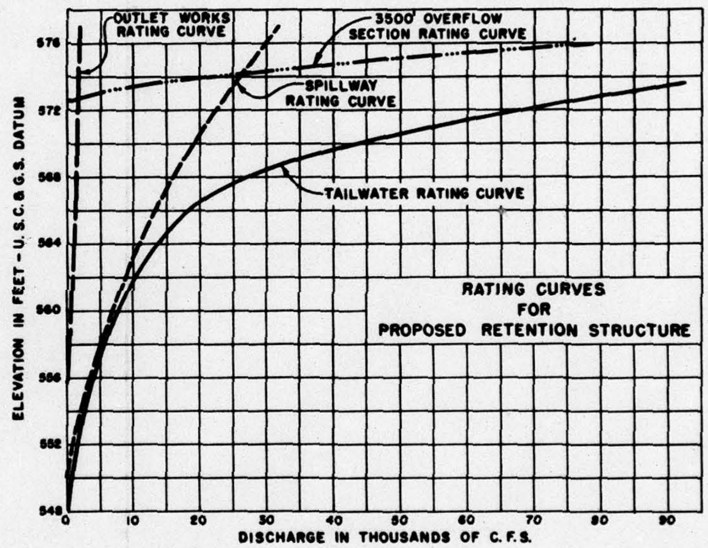
SUBSURFACE EXPLORATIONS-VICINITY OF PROPOSED RETENTION STRUCTURE



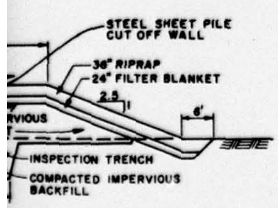
PROFILE ON AXIS OF RETENTION STRUCTURE

SCALE OF FEET (Horizontal) 1000' 0 1000' 2000'

SCALE OF FEET (Vertical) 10' 0 10' 20'



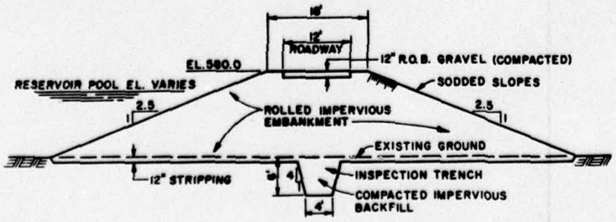
RATING CURVES FOR PROPOSED RETENTION STRUCTURE



ON B-B

FLOW SECTION

SCALE



SECTION C-C

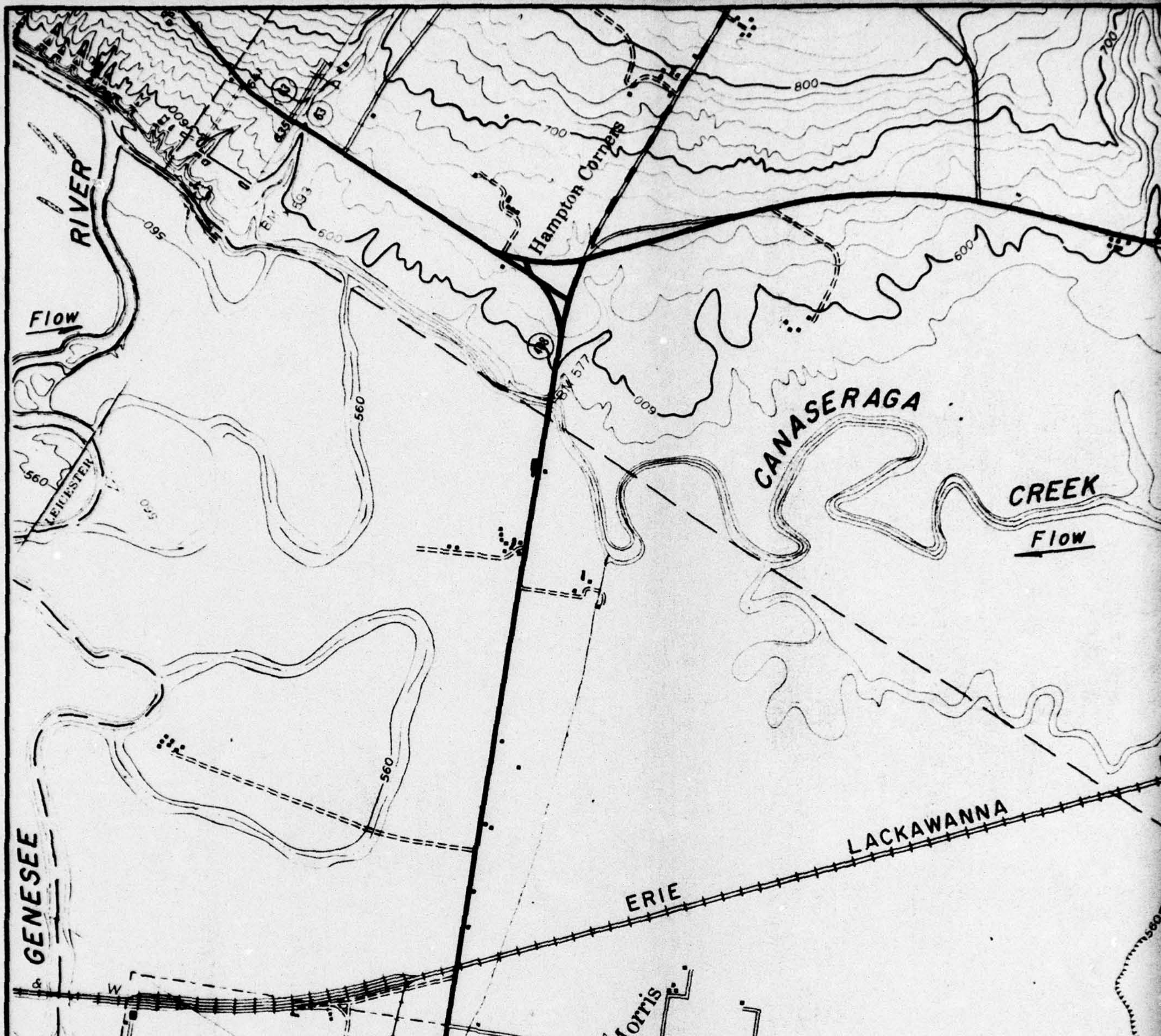
NON-OVERFLOW SECTION

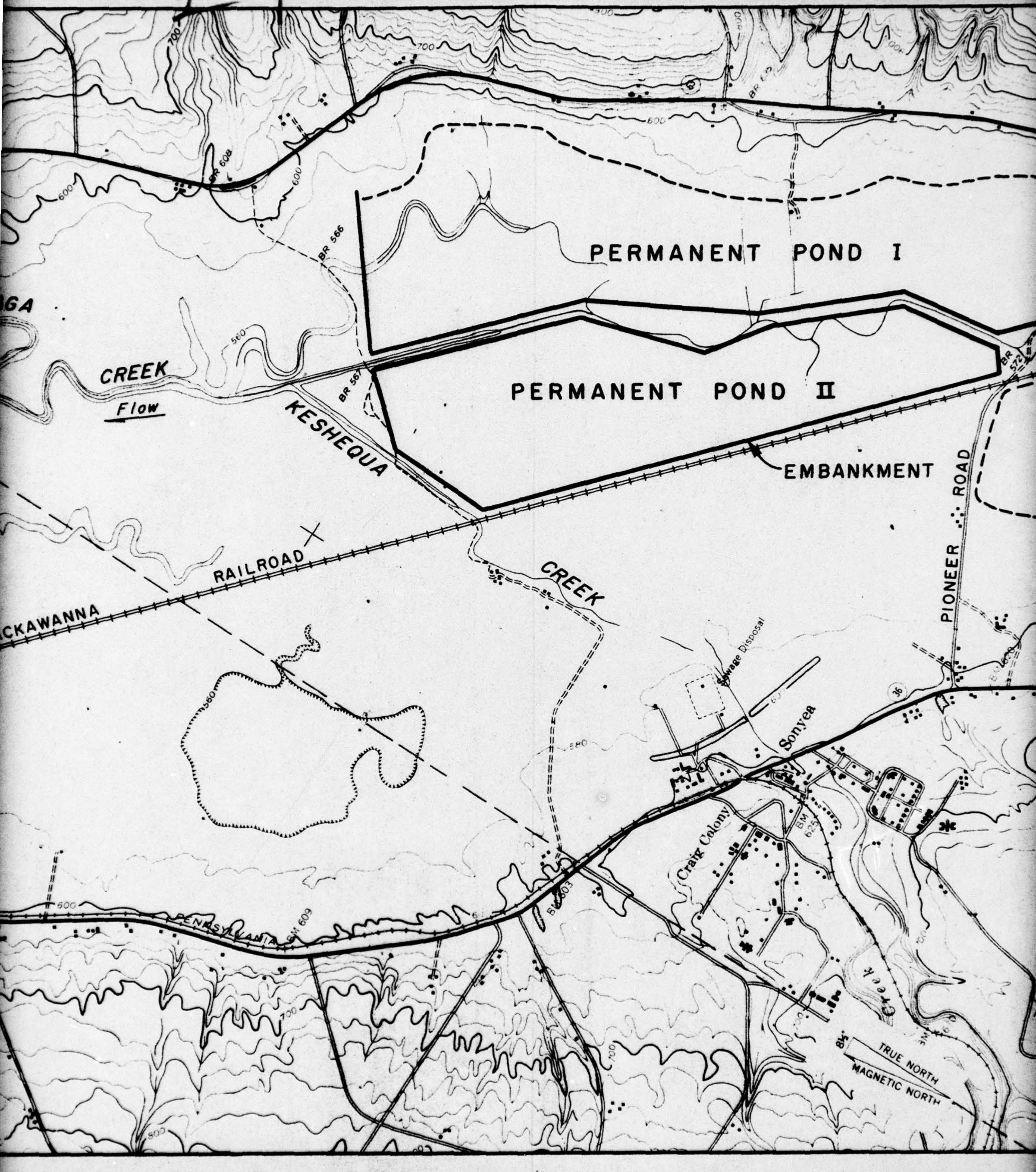
NOT TO SCALE

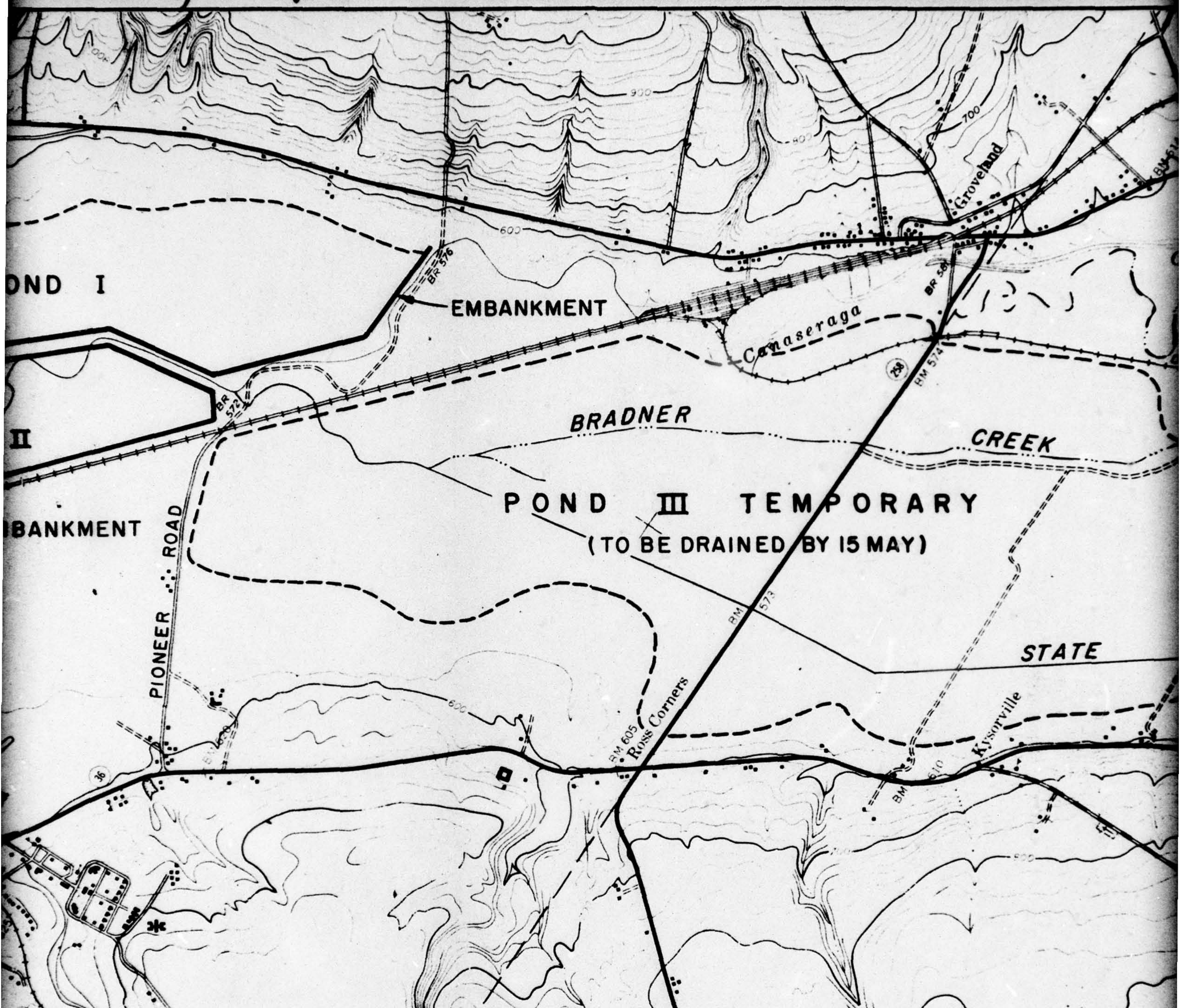
GENESEE RIVER BASIN
COMPREHENSIVE STUDY
NEW YORK AND PENNSYLVANIA
LOCAL PROTECTION PROJECT
CANASERAGA CREEK
LIVINGSTON COUNTY, NEW YORK

DETAILS-PROPOSED RETENTION STRUCTURE

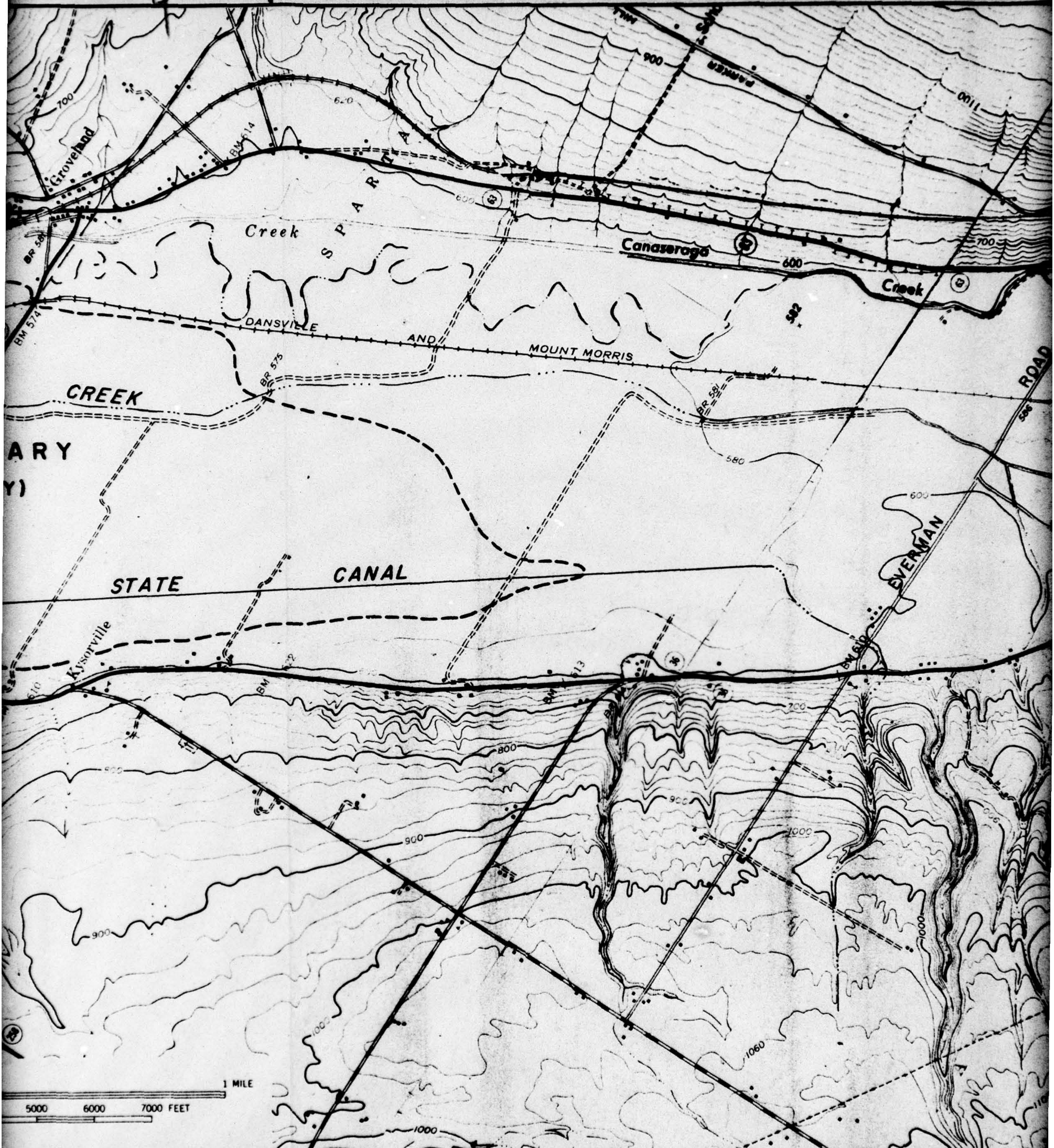
U.S. ARMY ENGINEER DISTRICT, BUFFALO
JUNE 1967


RIVER
Flow
Hampton Corners
CANASERAGA
CREEK
Flow
LEICESTER
LACKAWANNA
ERIE
GENESEE
Mount Morris
Mount Morris
PENN
800
700
600
560
BM 577
BM 598
BM 604
CEM

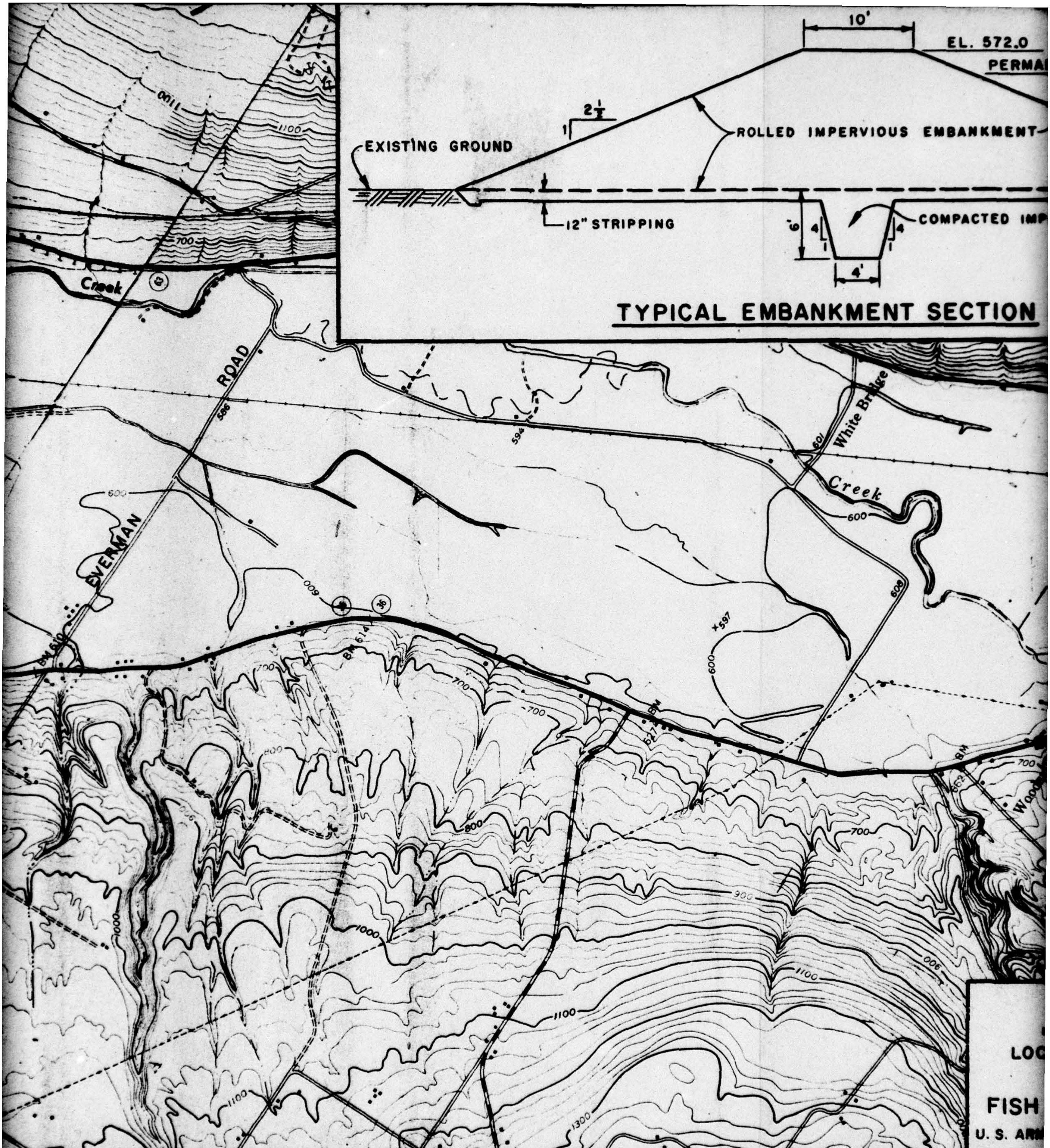

PERMANENT POND I
PERMANENT POND II
EMBANKMENT
KESHEQUA
CREEK
Flow
CREEK
RAILROAD
ACKAWANNA
PIONEER ROAD
Sonyea
Craig Colony
Sewage Disposal
PENNSYLVANIA
BR 608
BR 566
BR 567
BR 572
BM 609
BM 603
BM 625
TRUE NORTH
MAGNETIC NORTH
8½°
Creek
600
700
560
580



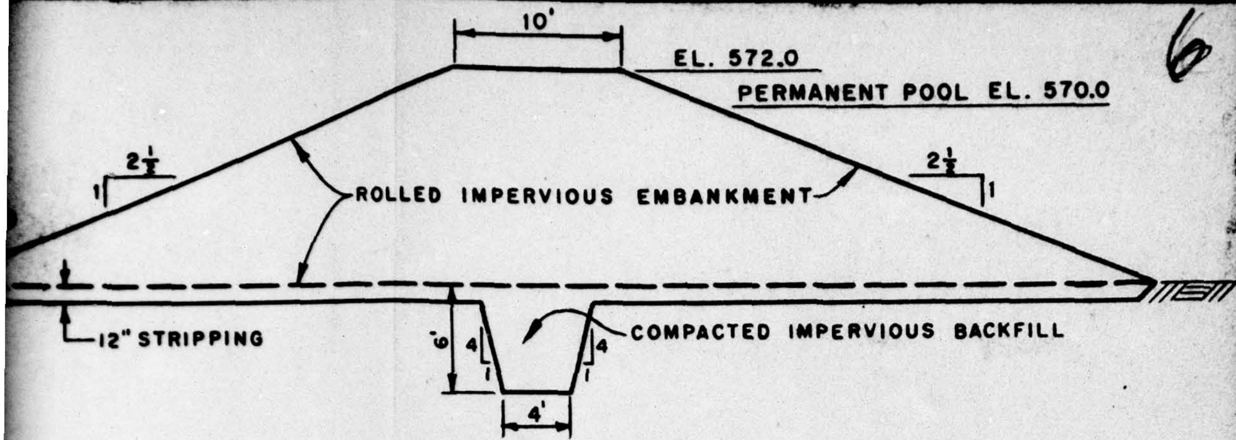
OND I
EMBANKMENT
II
BANKMENT
BRADNER
CREEK
POND III TEMPORARY
(TO BE DRAINED BY 15 MAY)
PIONEER ROAD
STATE
Canaseraga
Groveland
Ross Corners
Kysorville
BR 576
BR 572
BR 581
BM 574
BM 573
BM 605
TRUE NORTH
MAGNETIC NORTH
SCALE 1:24 000
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET



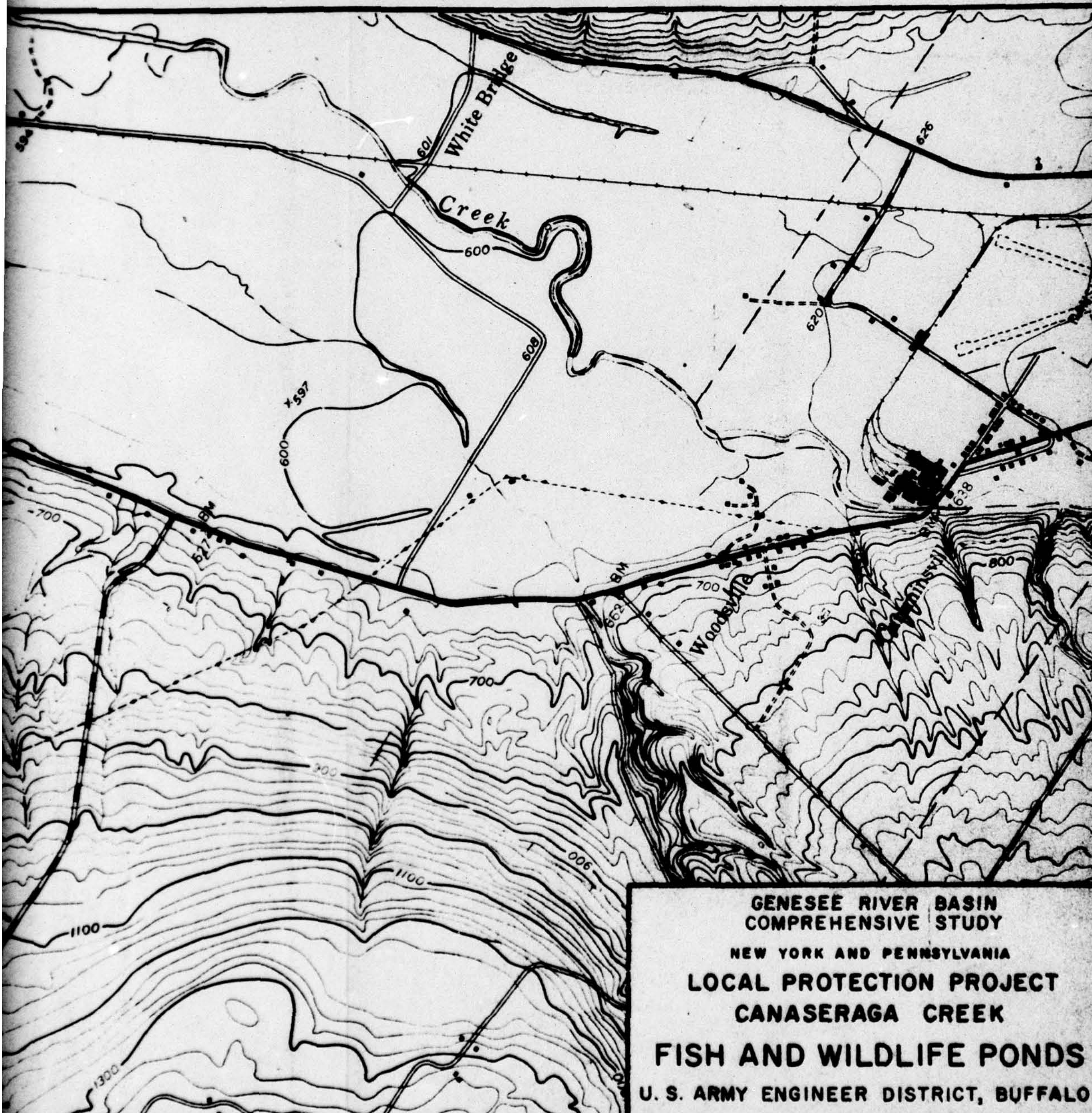
Groveland
SPARTA
Creek
Canaseraga
Creek
DANSVILLE
AND
MOUNT MORRIS
CREEK
ARY
Y)
STATE
CANAL
EVERMAN
ROAD
Kysorville
BM 614
BR 575
BR 581
BM 574
BM 610
1 MILE
5000
6000
7000 FEET


10'
EL. 572.0
PERMA
$2\frac{1}{2}$
1
ROLLED IMPERVIOUS EMBANKMENT
EXISTING GROUND
12" STRIPPING
6'
4
1
4'
COMPACTED IMP
TYPICAL EMBANKMENT SECTION
Creek
EVERMAN
ROAD
586
594
601
White Bridge
Creek
600
606
+597
BM 610
BM 614
BM 627
700
800
900
1000
1100
1300
LOC
FISH
U. S. ARM

6

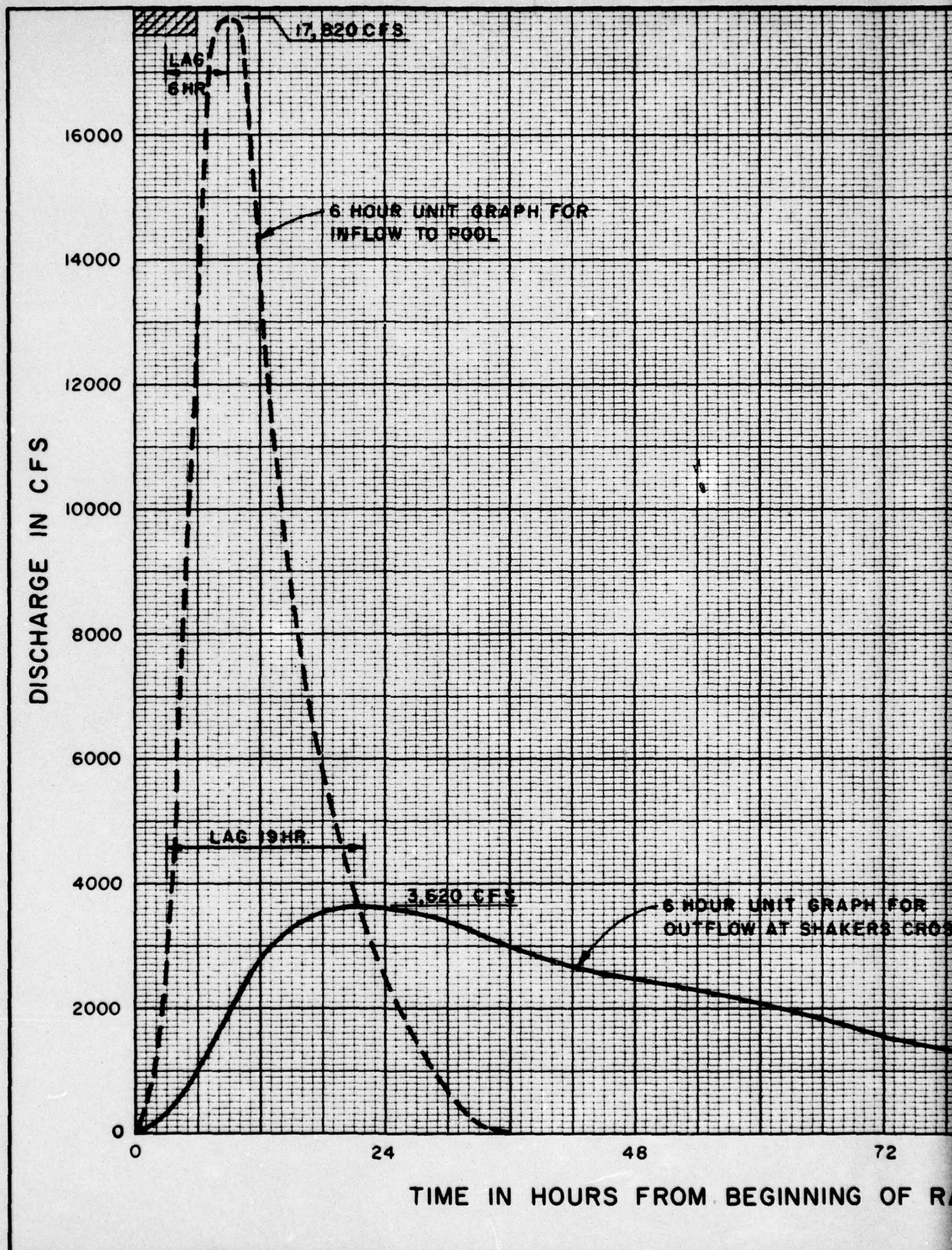


TYPICAL EMBANKMENT SECTION

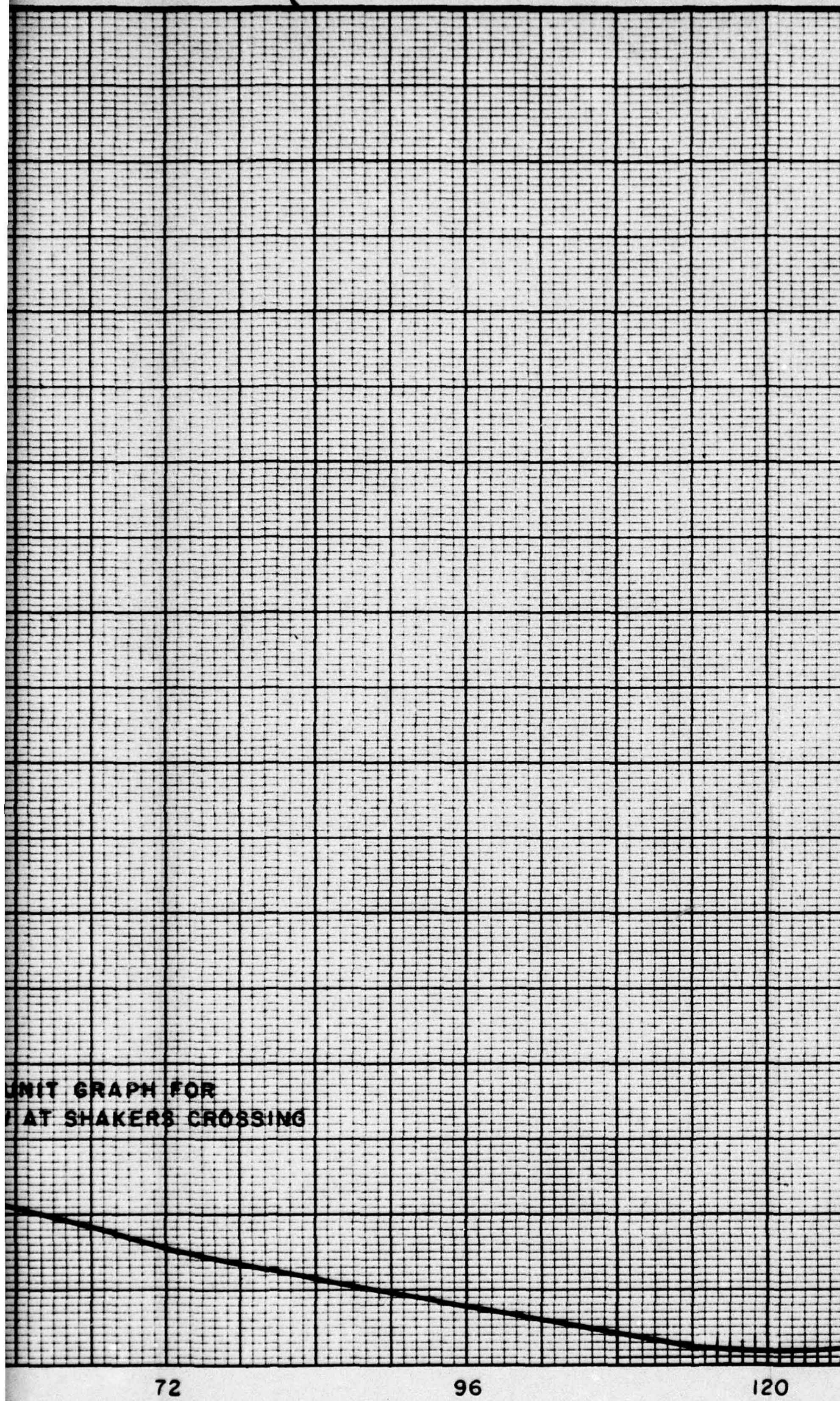


GENESEE RIVER BASIN
COMPREHENSIVE STUDY
NEW YORK AND PENNSYLVANIA
LOCAL PROTECTION PROJECT
CANASERAGA CREEK
FISH AND WILDLIFE PONDS
U. S. ARMY ENGINEER DISTRICT, BUFFALO

PLATE C10


17,820 CFS
LAG 6 HR.
6 HOUR UNIT GRAPH FOR INFLOW TO POOL
LAG 19 HR.
3,620 CFS
6 HOUR UNIT GRAPH FOR OUTFLOW AT SHAKERS CROS
DISCHARGE IN CFS
16000
14000
12000
10000
8000
6000
4000
2000
0
0
24
48
72
TIME IN HOURS FROM BEGINNING OF RA

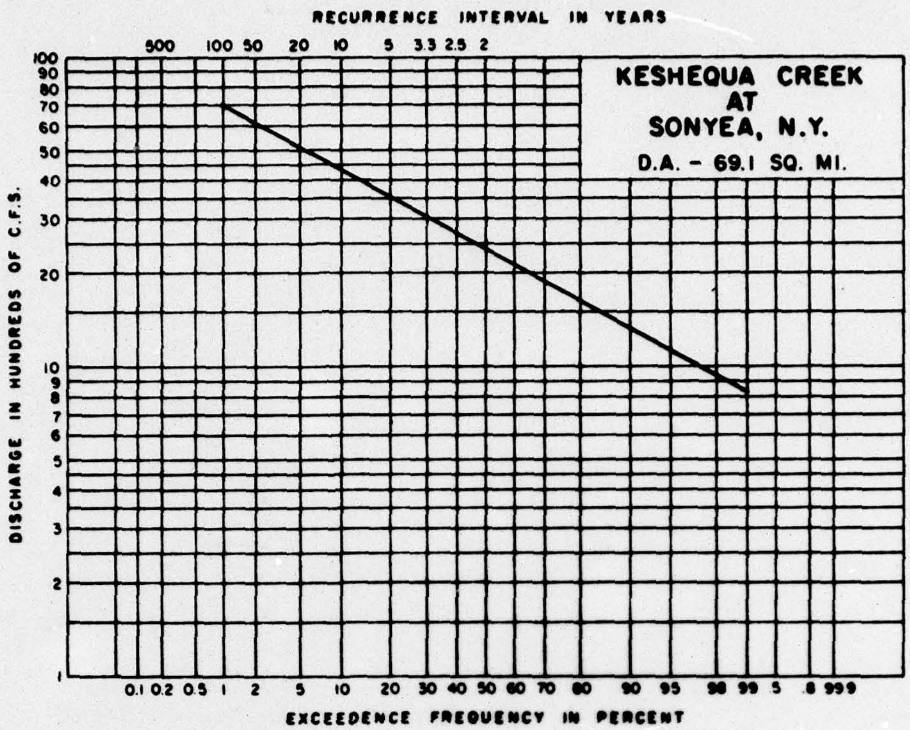
2

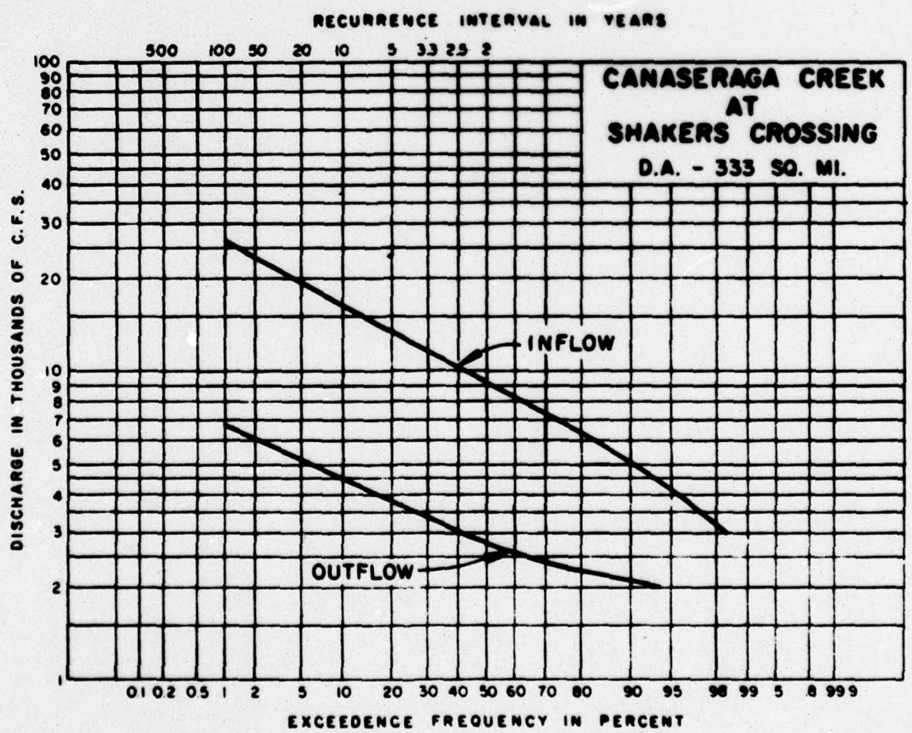


DRAINAGE AREA = 333 SQ. MI.

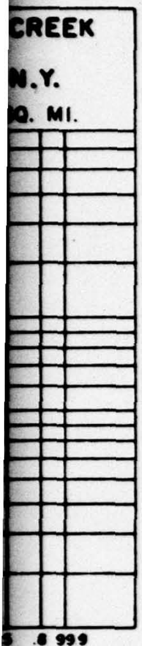
GENESEE RIVER BASIN
COMPREHENSIVE STUDY
NEW YORK AND PENNSYLVANIA
LOCAL PROTECTION PROJECT
CANASERAGA CREEK
SYNTHETIC UNIT HYDROGRAPHS
U.S. ARMY ENGINEER DISTRICT, BUFFALO

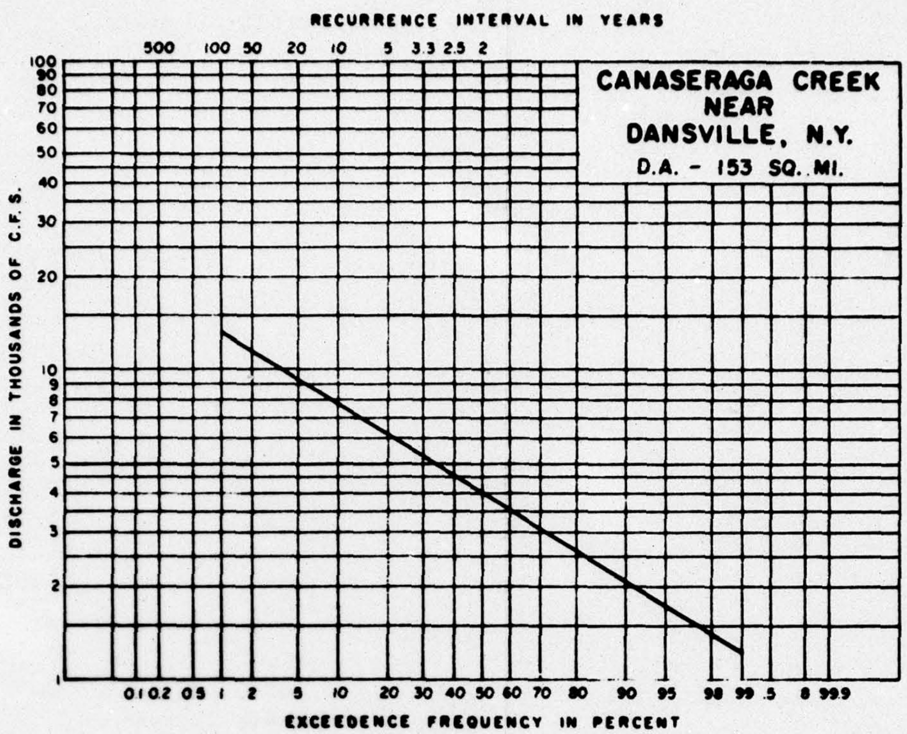
PLATE C11

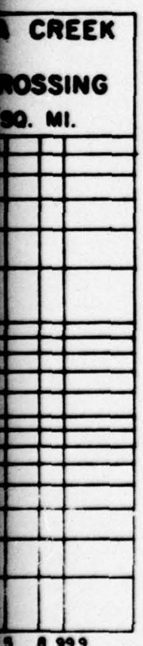

RECURRENCE INTERVAL IN YEARS
500 100 50 20 10 5 3.3 2.5 2
KESHEQUA CREEK
AT
SONYEA, N.Y.
D.A. - 69.1 SQ. MI.
DISCHARGE IN HUNDREDS OF C.F.S.
100 90 80 70 60 50 40 30 20 10 9 8 7 6 5 4 3 2 1
0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 5 .8 99.9
EXCEEDENCE FREQUENCY IN PERCENT


RECURRENCE INTERVAL IN YEARS
500 100 50 20 10 5 3.3 2.5 2
CANASERAGA CREEK
AT
SHAKERS CROSSING
D.A. - 333 SQ. MI.
DISCHARGE IN THOUSANDS OF C.F.S.
100 90 80 70 60 50 40 30 20 10 9 8 7 6 5 4 3 2 1
INFLOW
OUTFLOW
0.1 0.2 0.5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 5 .8 99.9
EXCEEDENCE FREQUENCY IN PERCENT

2







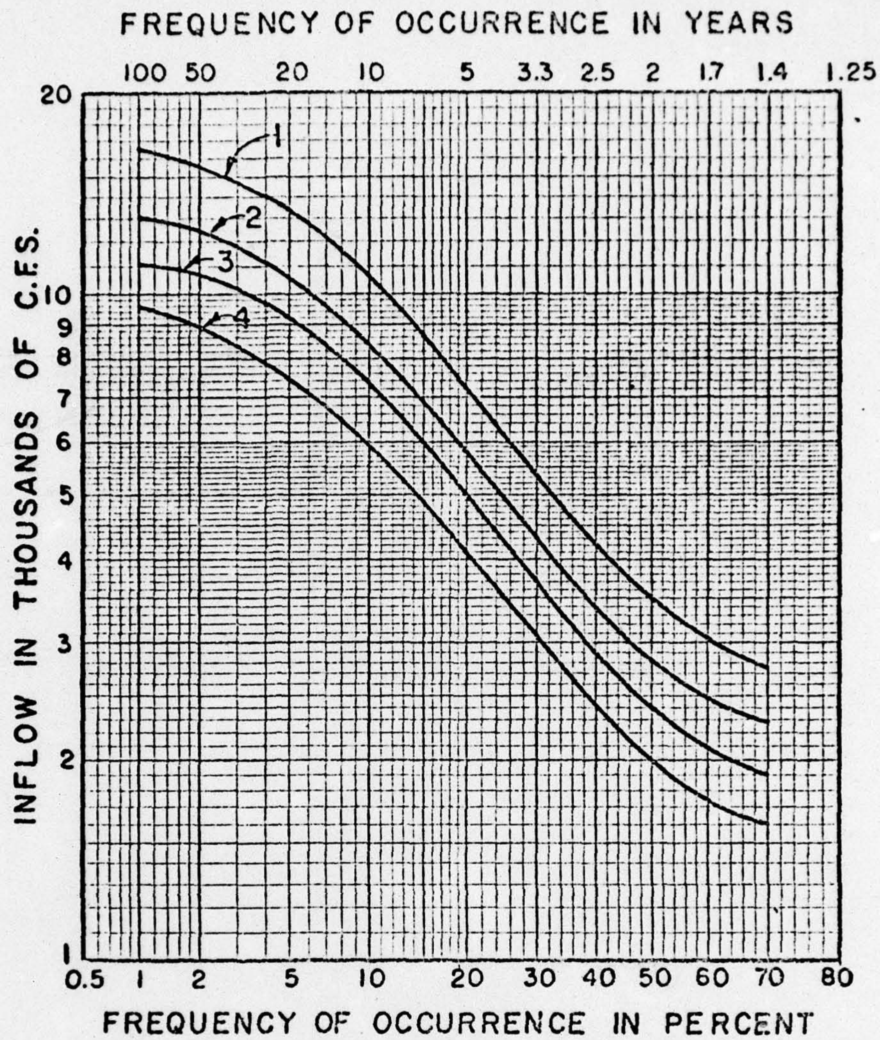
GENESEE RIVER BASIN
COMPREHENSIVE STUDY

NEW YORK AND PENNSYLVANIA

LOCAL PROTECTION PROJECT
CANASERAGA CREEK
ANNUAL EVENTS
DISCHARGE FREQUENCY CURVES

U. S. ARMY ENGINEER DISTRICT, BUFFALO

PLATE C12



CANASERAGA CREEK

$$Q_{Sub\text{-}Area} = Q_{Dansville} \left(\frac{D.A._{Sub\text{-}Area}}{D.A._{Dansville}} \right)^{0.77}$$

1. CANASERAGA CREEK AT SHAKERS CROSSING DRAINAGE AREA = 333 SQ. MI.
2. CANASERAGA CREEK UPSTREAM OF KESHEQUA CREEK DRAINAGE AREA = 239 SQ. MI.
3. CANASERAGA CREEK UPSTREAM OF BRADNER CREEK DRAINAGE AREA = 192 SQ. MI.
4. CANASERAGA CREEK AT DANSVILLE DRAINAGE AREA = 153 SQ. MI.

GENESEE RIVER BASIN
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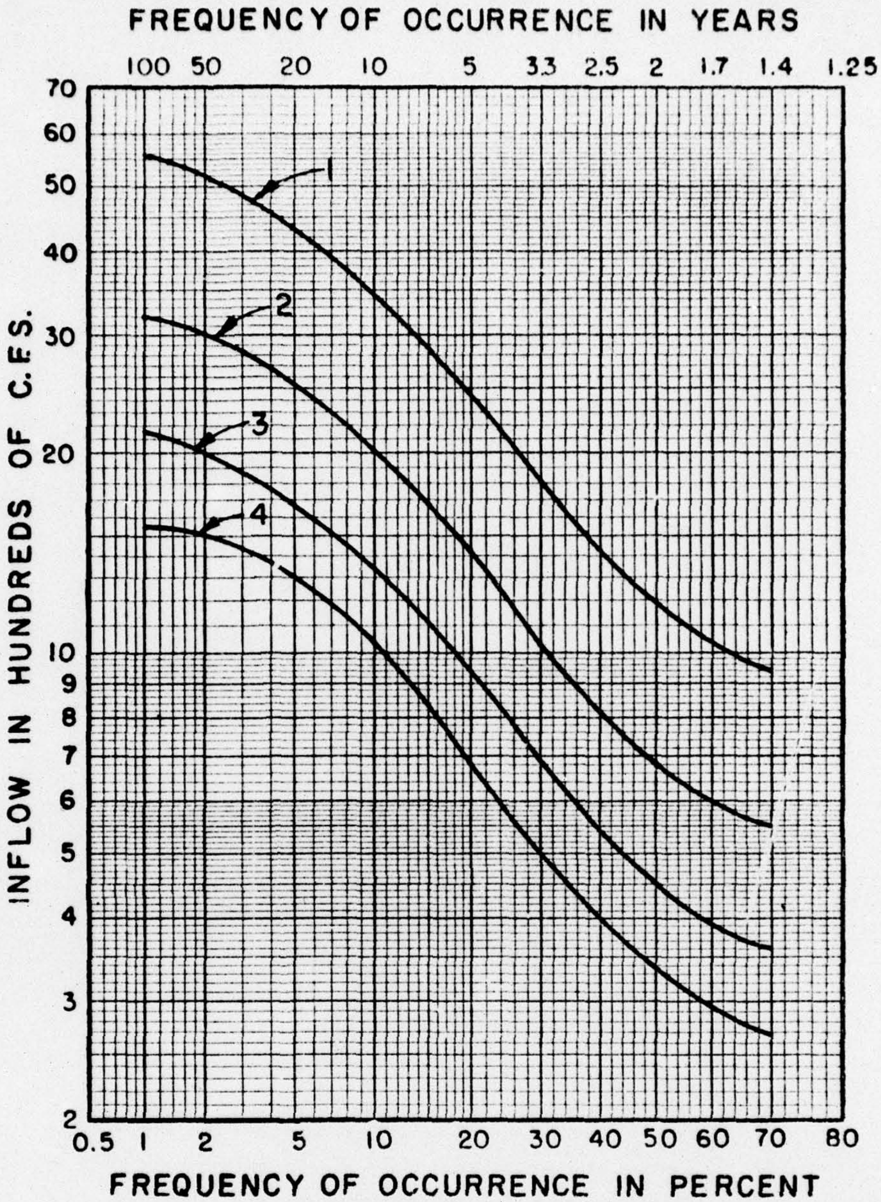
LOCAL PROTECTION PROJECT
CANASERAGA CREEK
SUMMER EVENTS
DISCHARGE-FREQUENCY CURVES
U. S. ARMY ENGINEER DISTRICT, BUFFALO

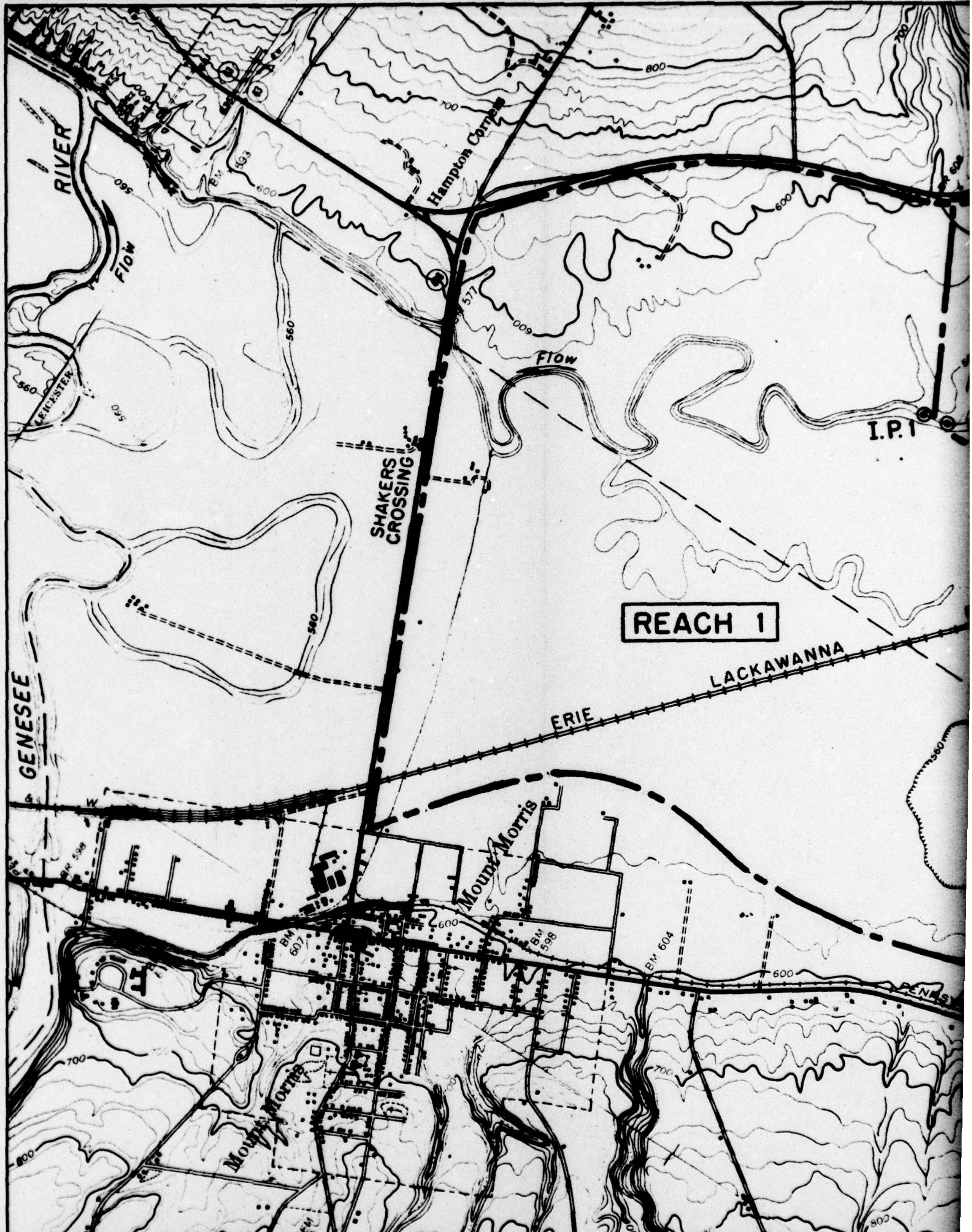


TRIBUTARY STREAMS

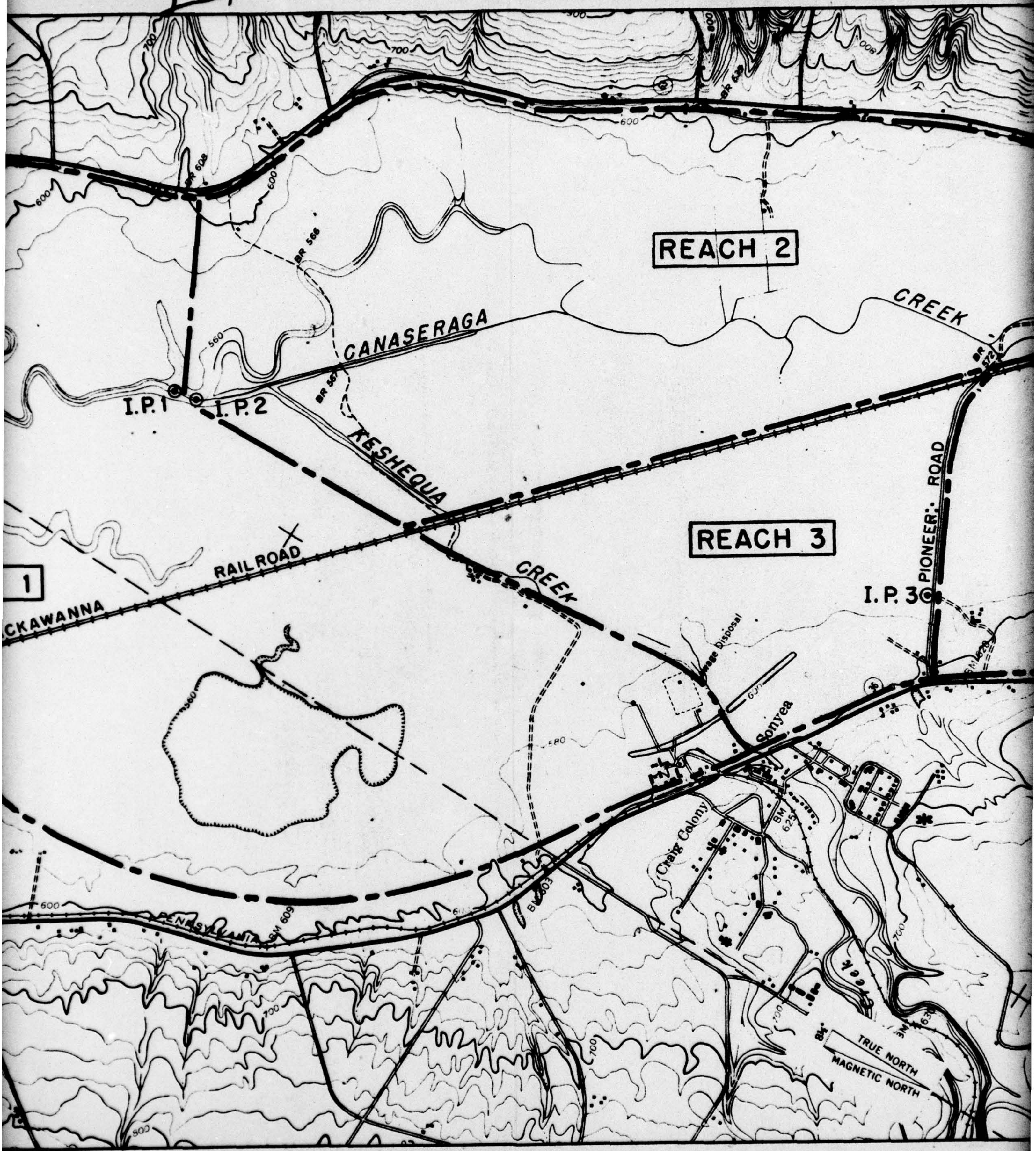
$$Q_{Tributary} = Q_{Dansville} \left(\frac{D.A._{Tributary}}{D.A._{Dansville}} \right)^{0.77}$$

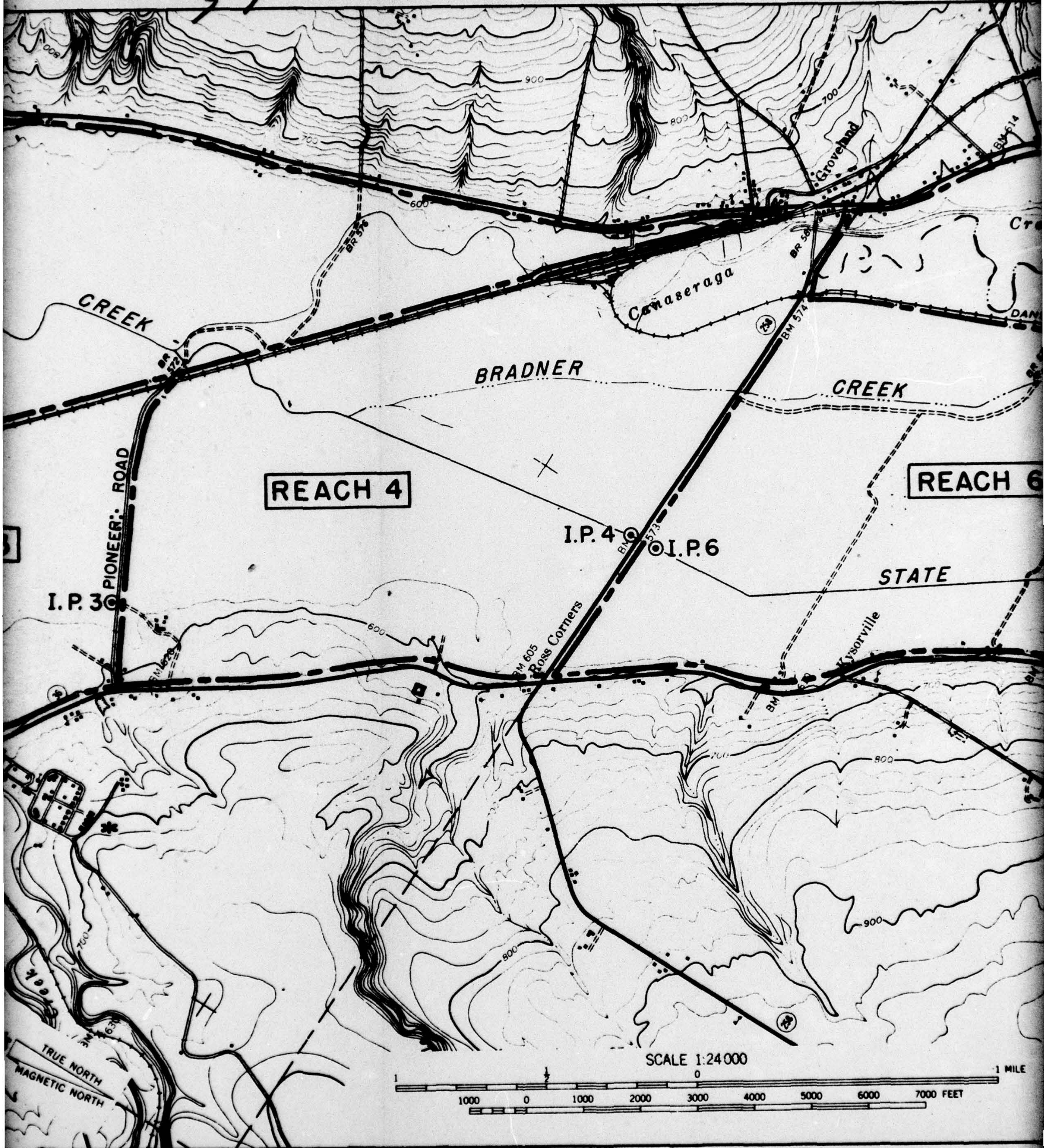
1. KESHEQUA CREEK
   DRAINAGE AREA = 76 SQ. MI.
2. BRADNER CREEK AT MOUTH
   DRAINAGE AREA = 37 SQ. MI.
3. STATE CANAL
   DRAINAGE AREA = 22 SQ. MI.
4. BRADNER CREEK UPSTREAM OF STATE
   CANAL DRAINAGE AREA = 15 SQ. MI.

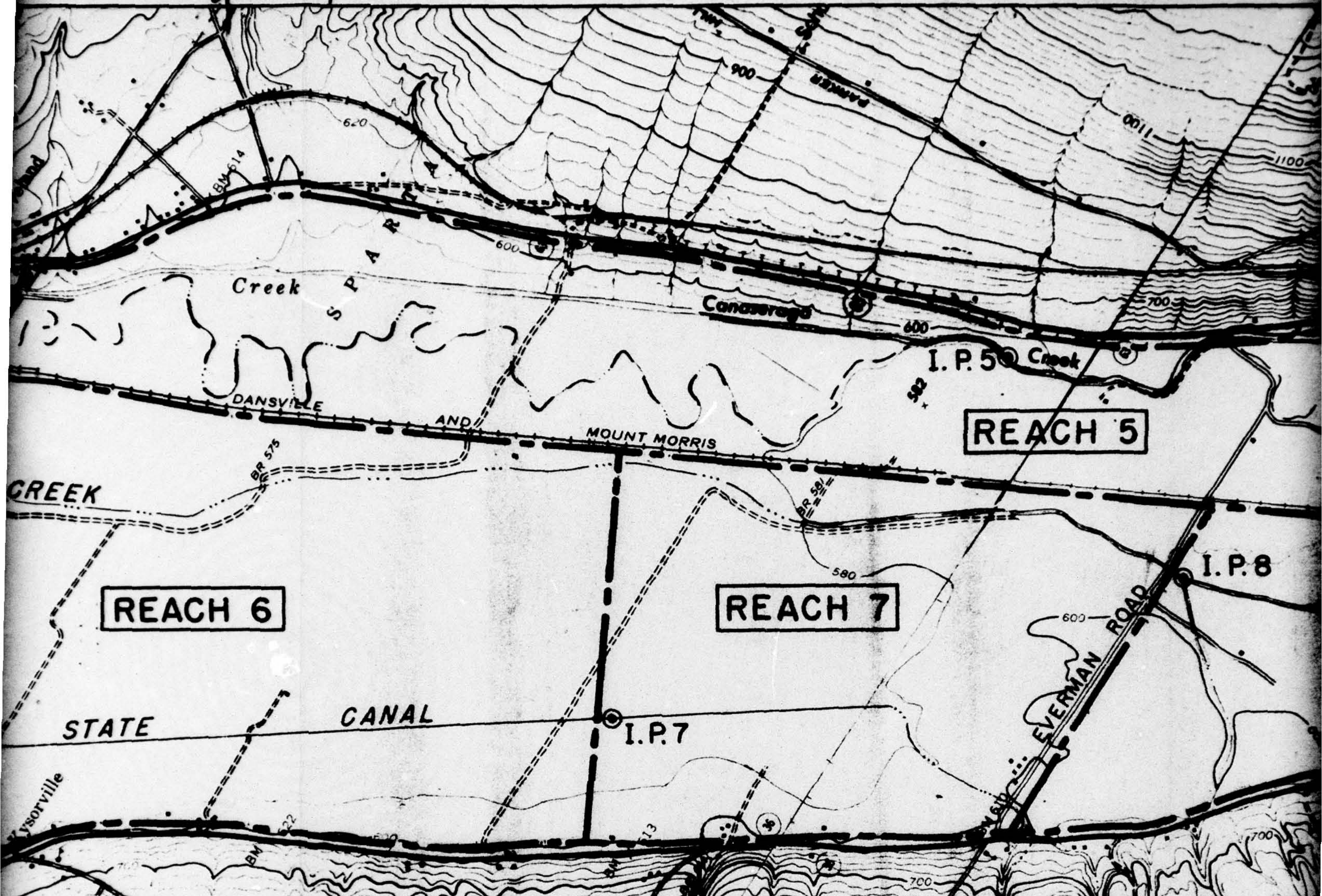
GENESEE RIVER BASIN
COMPREHENSIVE STUDY
NEW YORK AND PENNSYLVANIA
LOCAL PROTECTION PROJECT
CANASERAGA CREEK
SUMMER EVENTS
DISCHARGE-FREQUENCY CURVES
U. S. ARMY ENGINEER DISTRICT, BUFFALO

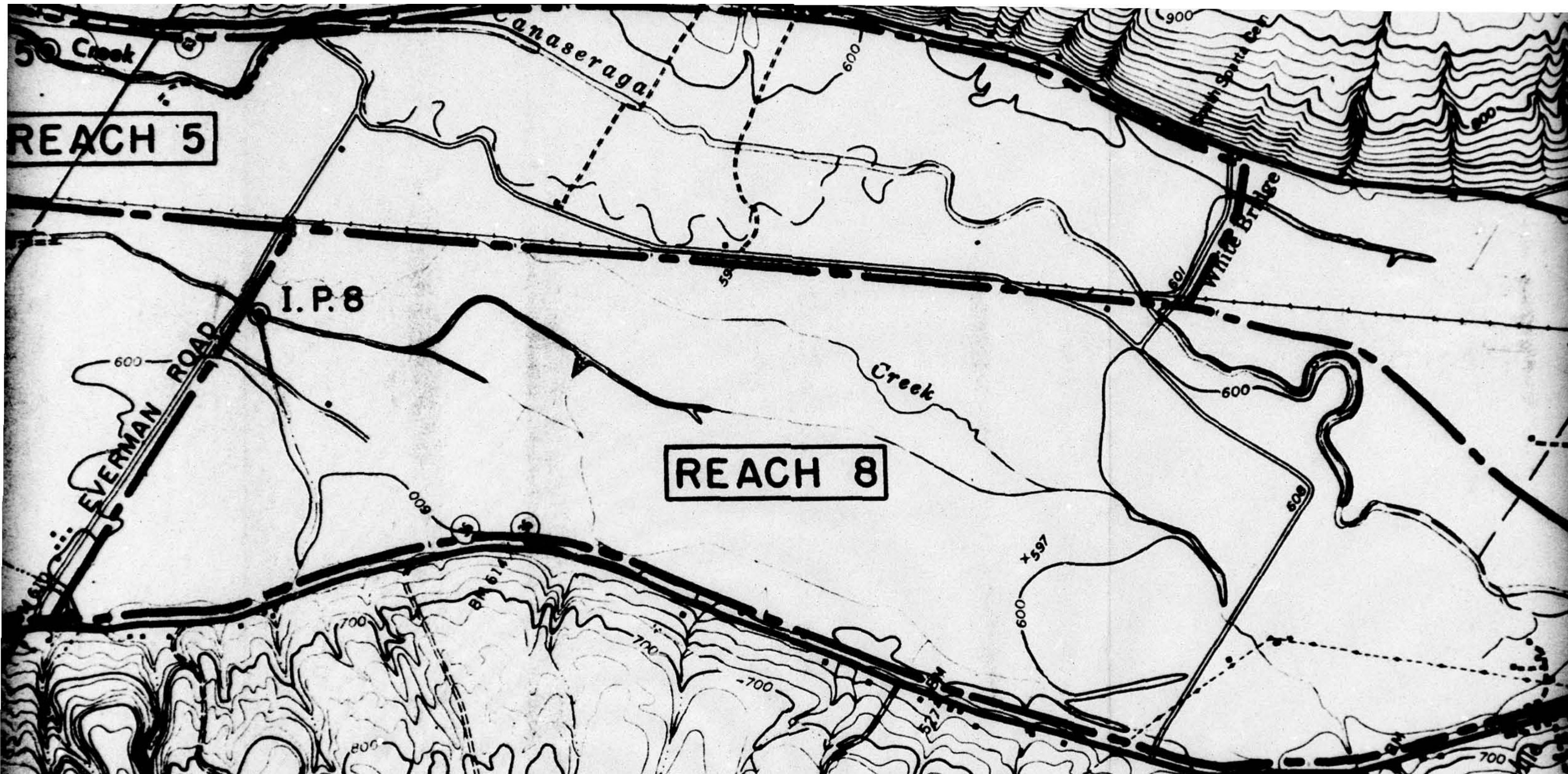


REACH 1
GENESEE
RIVER
Flow
Flow
Hampton Corners
SHAKERS CROSSING
I.P.1
ERIE
LACKAWANNA
Mount Morris
Mount Morris
BM 607
BM 598
BM 604
LEICESTER
800
700
600
560
577


REACH 2
REACH 3
1
CANASERAGA
CREEK
KESHEQUA
CREEK
I.P. 1
I.P. 2
I.P. 3
PIONEER ROAD
RAILROAD
CKAWANNA
PENNSYLVANIA
Sonyea
Craig Colony
TRUE NORTH
MAGNETIC NORTH
BR 608
BR 566
BR 507
BR 572
BM 609
BM 625
BM 603
BM 620
600
560
700
800


CREEK
BRADNER
CREEK
Canaseraga
Groveland
REACH 4
REACH 6
PIONEER ROAD
I.P. 3
I.P. 4
I.P. 6
STATE
Ross Corners
Kysorville
BM 605
BM 574
BM 614
BR 576
BR 572
900
800
700
600
SCALE 1:24000
1 MILE
1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
TRUE NORTH
MAGNETIC NORTH

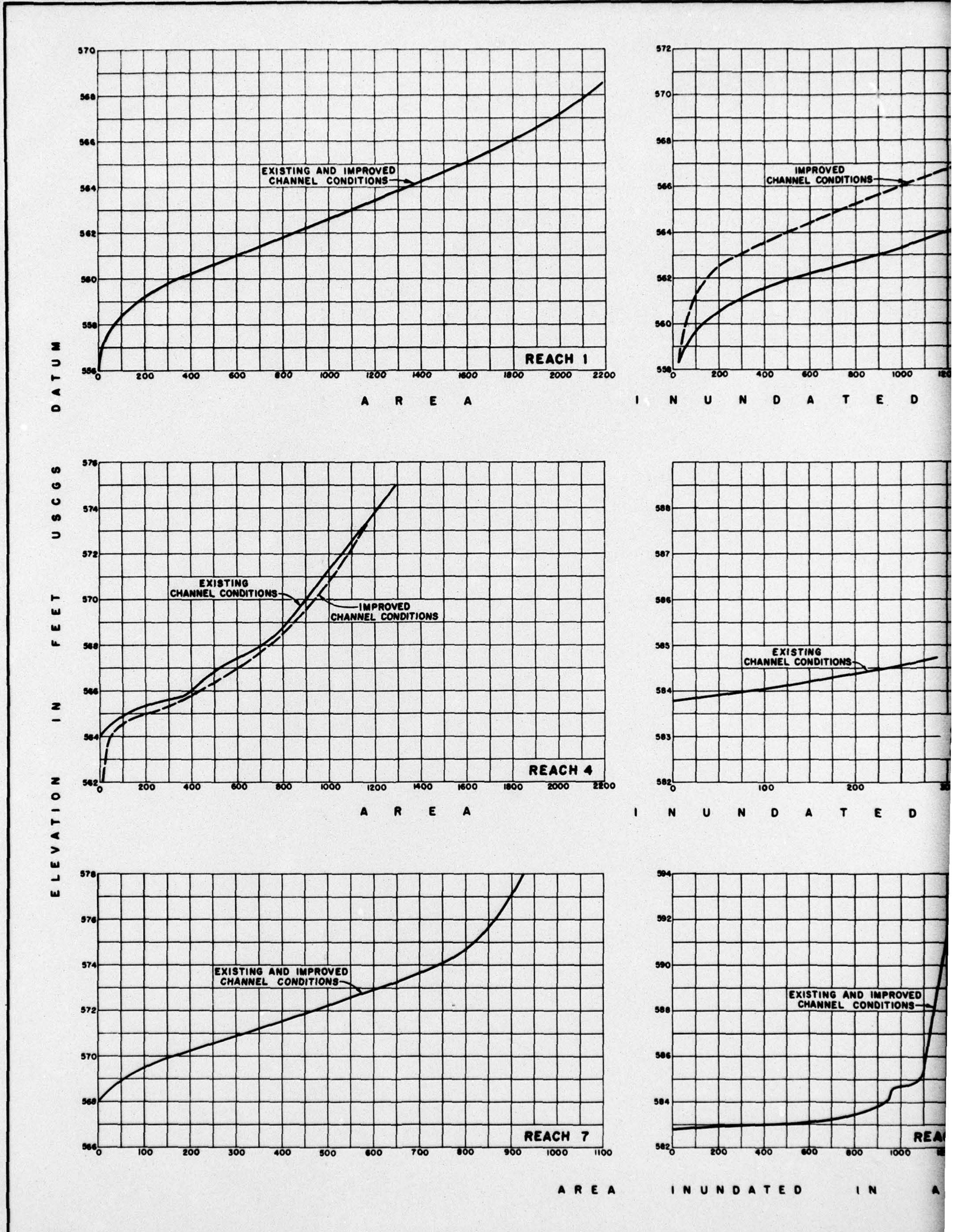

REACH 5
REACH 6
REACH 7
I. P. 5
I. P. 7
I. P. 8
Canaseraga
Creek
CREEK
STATE
CANAL
DANSVILLE
AND
MOUNT MORRIS
EVERMAN ROAD
SPARTA
1 MILE
6000
7000 FEET



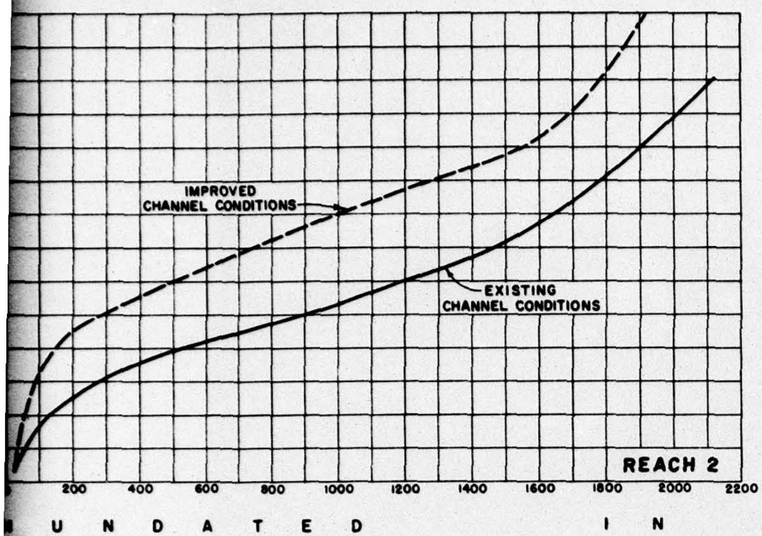
Creek
Canaseraga
REACH 5
EVERMAN ROAD
I.P. 8
White Bridge
Creek
REACH 8
600
700
800
900
1000
1100
1300
GEN
COR
NEW Y
LOCAL F
CAN
DAM
U.S. ARMY E

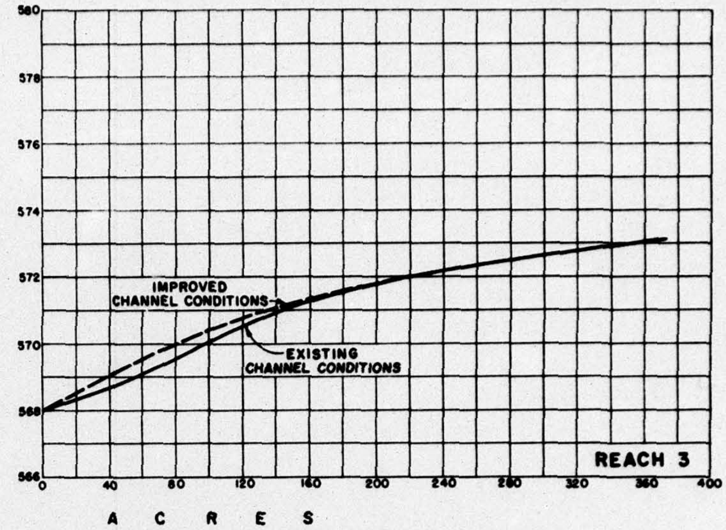

LEGEND
REACH 6 DAMAGE REACH
INDEX POINTS FOR DAMAGE REACHES
1000
900
800
700
600
White Bridge
601
608
620
626
638
597
1100
GENESEE RIVER BASIN
COMPREHENSIVE STUDY
NEW YORK AND PENNSYLVANIA
LOCAL PROTECTION PROJECT
CANASERAGA CREEK
DAMAGE REACHES
U.S. ARMY ENGINEER DISTRICT, BUFFALO

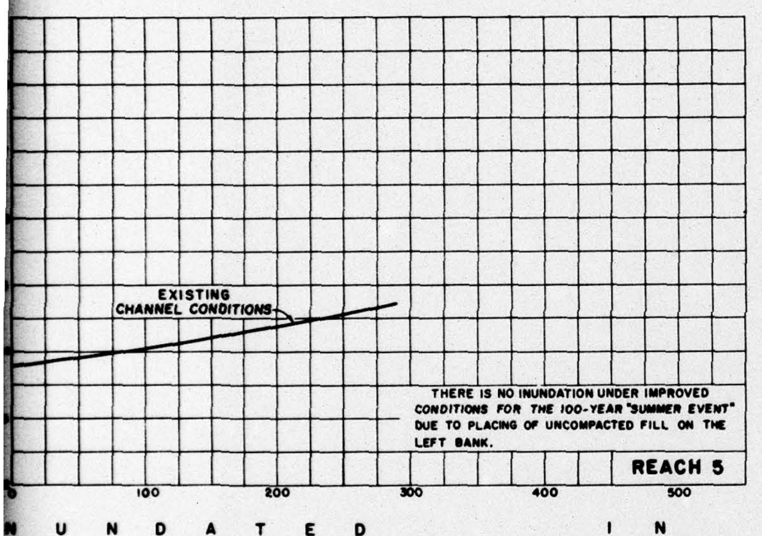
PLATE C15

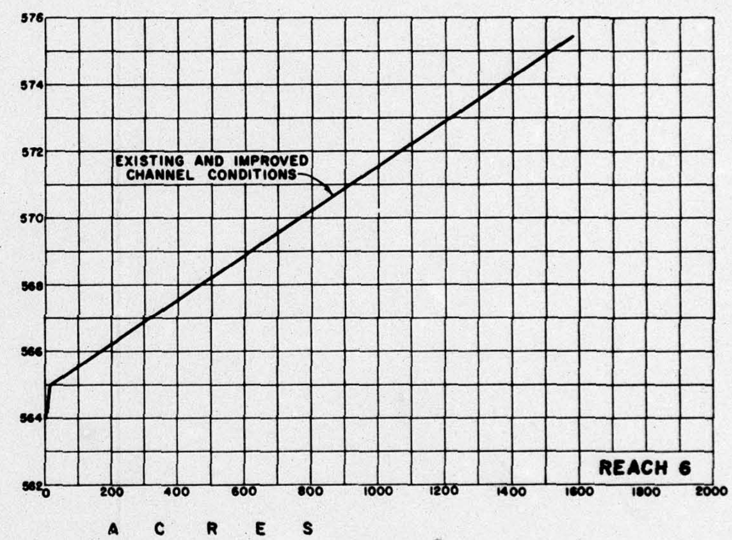


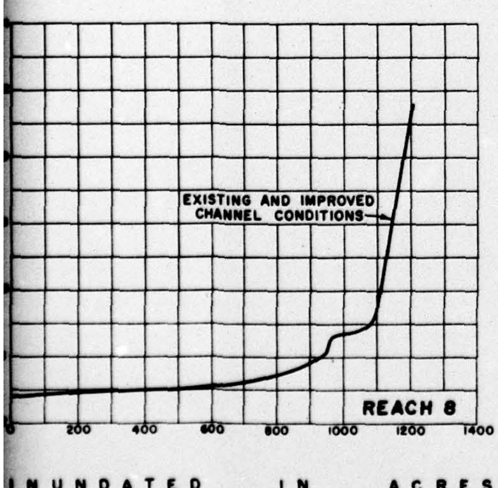
ELEVATION IN FEET USCGS DATUM
EXISTING AND IMPROVED CHANNEL CONDITIONS
REACH 1
AREA INUNDATED
IMPROVED CHANNEL CONDITIONS
EXISTING CHANNEL CONDITIONS
IMPROVED CHANNEL CONDITIONS
REACH 4
AREA INUNDATED
EXISTING CHANNEL CONDITIONS
EXISTING AND IMPROVED CHANNEL CONDITIONS
REACH 7
EXISTING AND IMPROVED CHANNEL CONDITIONS
AREA INUNDATED IN A











NOTES:

REACHES SHOWN ON THIS PLATE ARE REFERRED TO DAMAGE REACH MAP, PLATE C15.

INDEX POINT LOCATIONS

REACH 1 - ON CANASERAGA CREEK 1600' DOWNSTREAM OF THE CONFLUENCE WITH KESHEQUA CREEK.

REACH 2 - ON CANASERAGA CREEK 1400' DOWNSTREAM OF THE CONFLUENCE WITH KESHEQUA CREEK.

REACH 3 - 100' DOWNSTREAM OF PIONEER ROAD AND 1500' EAST OF STATE ROUTE 36.

REACH 4 - 100' DOWNSTREAM OF STATE ROUTE 258 ON STATE CANAL.

REACH 5 - ON CANASERAGA CREEK APPROXIMATELY 3500' NORTH OF EVERMAN ROAD BRIDGE AND 50' UPSTREAM OF AN EXISTING FARM BRIDGE.

REACH 6 - 100' UPSTREAM OF STATE ROUTE 258 ON STATE CANAL.

REACH 7 - 7200' DOWNSTREAM OF EVERMAN ROAD ON STATE CANAL.

REACH 8 - ON BRADNER CREEK 100' UPSTREAM OF EVERMAN ROAD.

A SLOPING POOL UNDER EXISTING CONDITIONS AND A LEVEL POOL UNDER IMPROVED CONDITIONS DUE TO MORE EFFICIENT CHANNELS NECESSITATED USE OF DIFFERENT STAGE-AREA CURVES IN REACHES 2, 3 AND 4.

LEGEND

——— EXISTING CHANNEL CONDITIONS

– – – IMPROVED CONDITIONS

GENESEE RIVER BASIN
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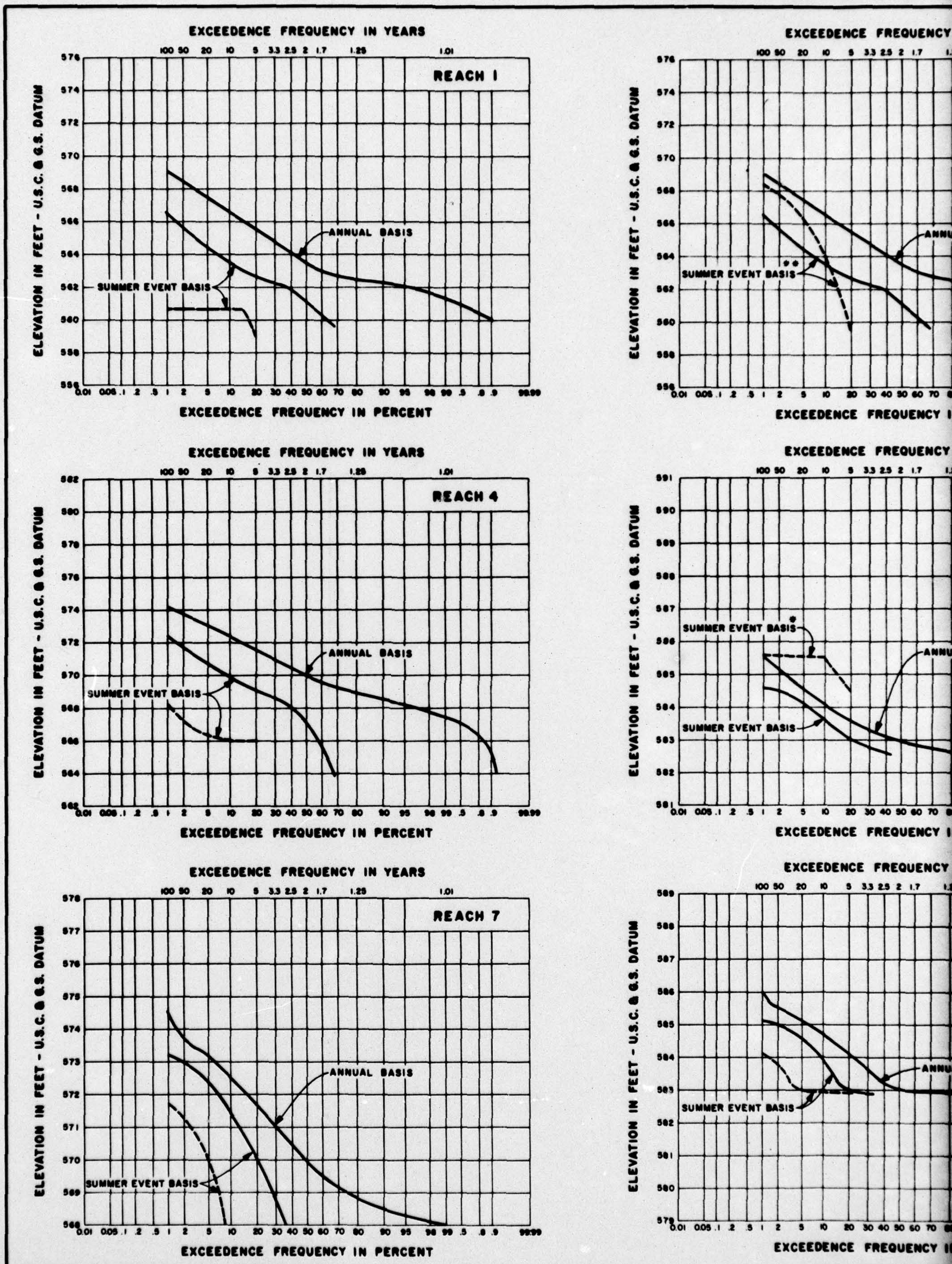
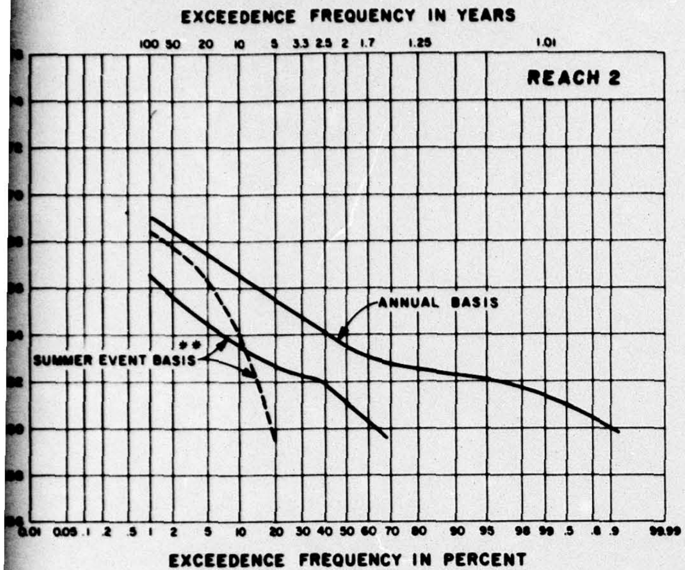
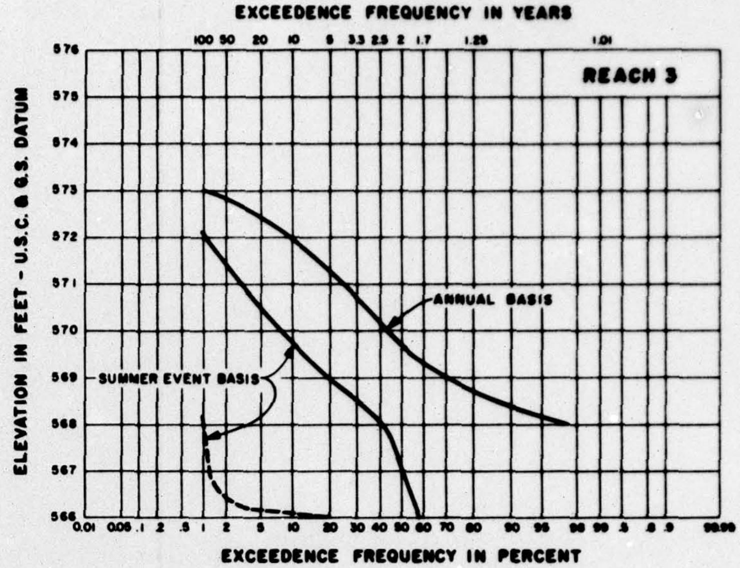
NEW YORK AND PENNSYLVANIA
LOCAL PROTECTION PROJECT
CANASERAGA CREEK
LIVINGSTON COUNTY, NEW YORK

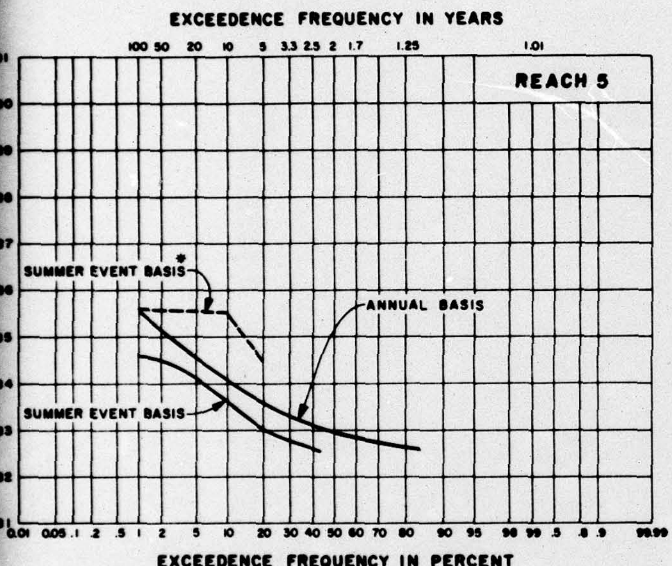
STAGE-AREA INUNDATED CURVES

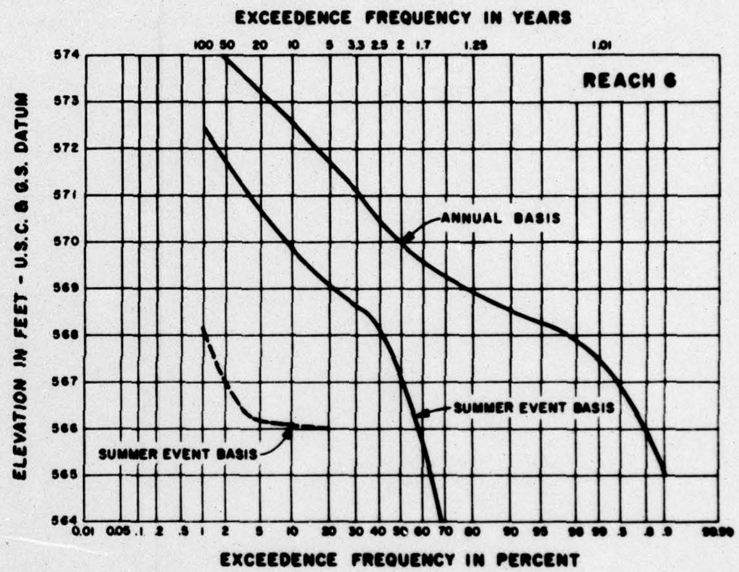
U.S. ARMY ENGINEER DISTRICT, BUFFALO
JUNE 1967

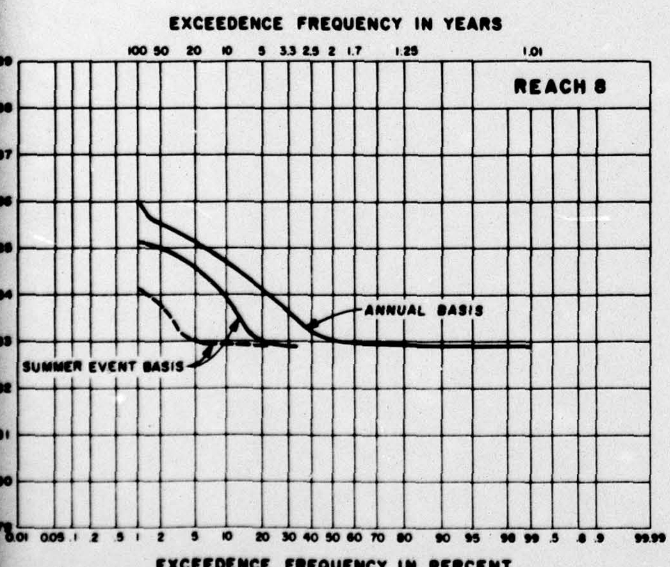

EXCEEDENCE FREQUENCY IN YEARS
100 50 20 10 5 3.3 2.5 2 1.7 1.25 1.01
REACH 1
ELEVATION IN FEET - U.S.C. & G.S. DATUM
ANNUAL BASIS
SUMMER EVENT BASIS
0.01 0.05 .1 .2 .5 1 2 5 10 20 30 40 50 60 70 80 90 95 98 99 .5 .8 .9 99.99
EXCEEDENCE FREQUENCY IN PERCENT
EXCEEDENCE FREQUENCY
ELEVATION IN FEET - U.S.C. & G.S. DATUM
ANNUA
SUMMER EVENT BASIS
EXCEEDENCE FREQUENCY IN YEARS
REACH 4
ELEVATION IN FEET - U.S.C. & G.S. DATUM
ANNUAL BASIS
SUMMER EVENT BASIS
EXCEEDENCE FREQUENCY IN PERCENT
EXCEEDENCE FREQUENCY
ELEVATION IN FEET - U.S.C. & G.S. DATUM
SUMMER EVENT BASIS
ANNUA
SUMMER EVENT BASIS
EXCEEDENCE FREQUENCY IN YEARS
REACH 7
ELEVATION IN FEET - U.S.C. & G.S. DATUM
ANNUAL BASIS
SUMMER EVENT BASIS
EXCEEDENCE FREQUENCY IN PERCENT
EXCEEDENCE FREQUENCY
ELEVATION IN FEET - U.S.C. & G.S. DATUM
ANNUA
SUMMER EVENT BASIS











NOTES:

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INDEX POINT LOCATIONS

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REACH 2 - ON CANASERAGA CREEK 1400' DOWNSTREAM OF THE CONFLUENCE WITH KESHEQUA CREEK.

REACH 3 - 100' DOWNSTREAM OF PIONEER ROAD AND 1500' EAST OF STATE ROUTE 36.

REACH 4 - 100' DOWNSTREAM OF STATE ROUTE 258 ON STATE CANAL.

REACH 5 - ON CANASERAGA CREEK APPROXIMATELY 3500' NORTH OF EVERMAN ROAD BRIDGE AND 50' UPSTREAM OF AN EXISTING FARM BRIDGE.

REACH 6 - 100' UPSTREAM OF STATE ROUTE 258 ON STATE CANAL.

REACH 7 - 7200' DOWNSTREAM OF EVERMAN ROAD ON STATE CANAL.

REACH 8 - ON BRADNER CREEK 100' UPSTREAM OF EVERMAN ROAD.

* ALTHOUGH THE STAGE IN REACH 5 IS HIGHER UNDER IMPROVED CONDITIONS THAN UNDER EXISTING CONDITIONS, CASTING OF CHANNEL EXCAVATED MATERIAL AS UNCOMPACTED FILL ON THE LEFT BANK WOULD PREVENT OVERBANK FLOODING.

* * ALTHOUGH THE STAGE AT I.P. 2 WOULD BE HIGHER UNDER IMPROVED CONDITIONS FOR A GIVEN EVENT, THE AREA INUNDATED FOR THE SAME EVENT WOULD BE LESS THAN UNDER EXISTING CONDITIONS BECAUSE OF THE LEVEL POOL.

LEGEND

———— EXISTING CHANNEL CONDITIONS

— — — — IMPROVED CONDITIONS

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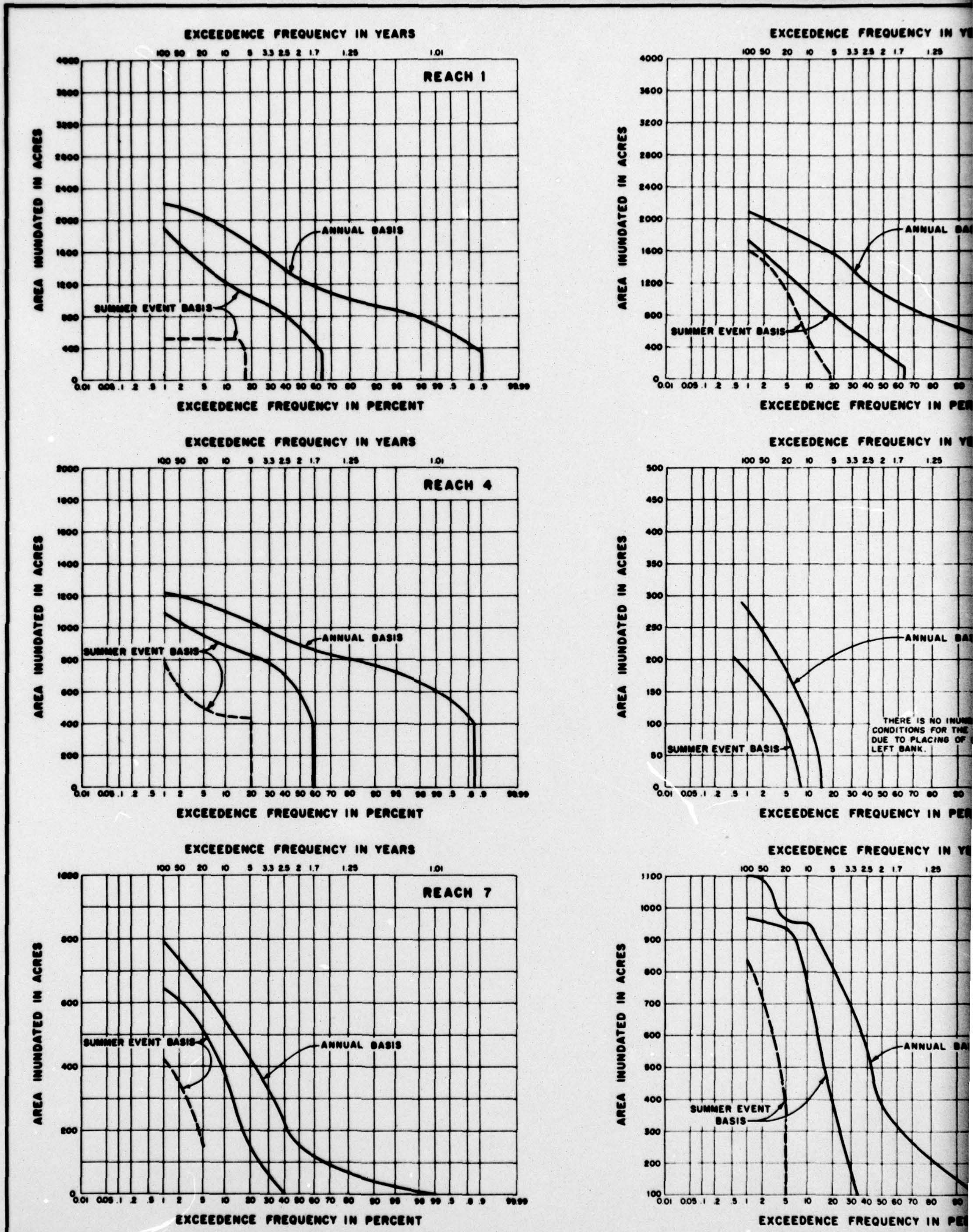
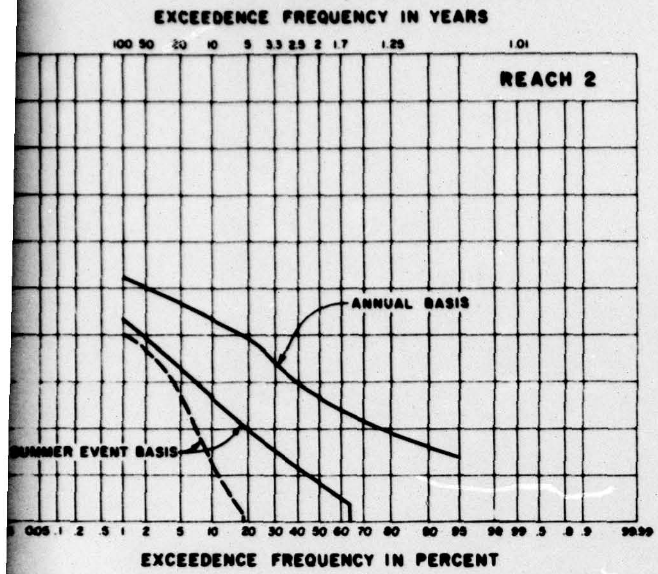
CANASERAGA CREEK
LIVINGSTON COUNTY, NEW YORK

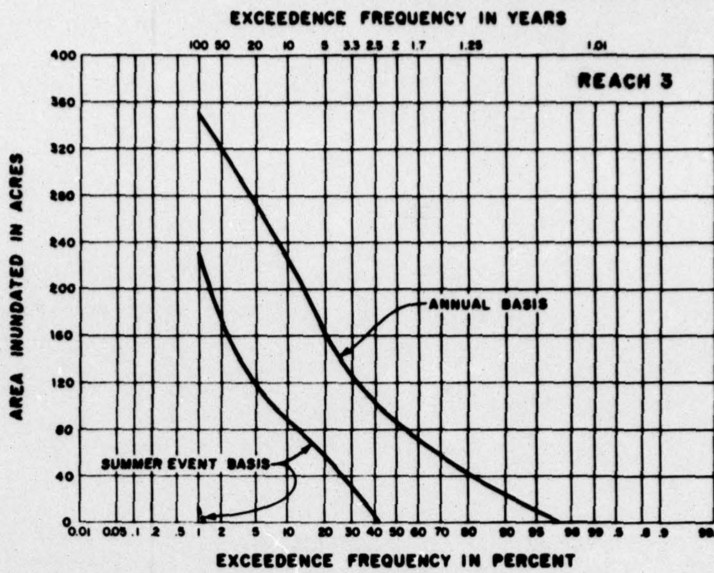
STAGE FREQUENCY CURVES

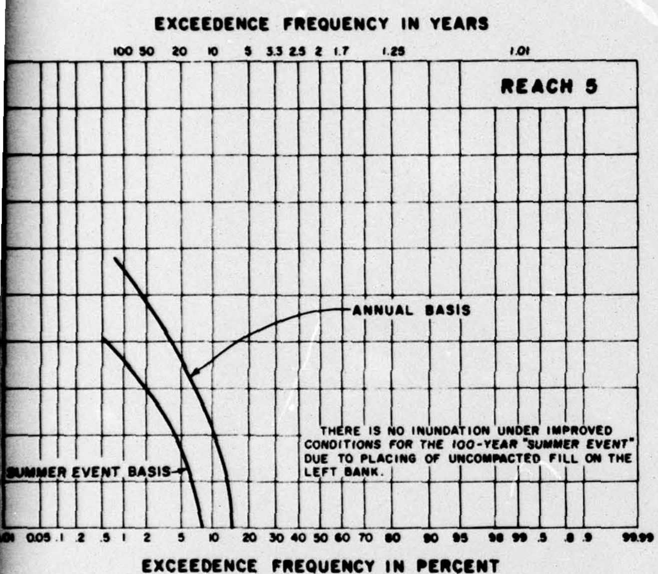
U.S. ARMY ENGINEER DISTRICT, BUFFALO
JUNE 1967

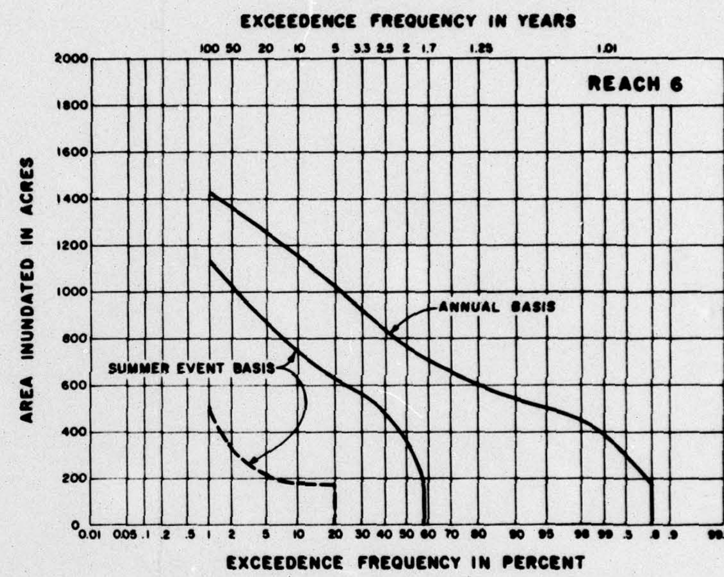


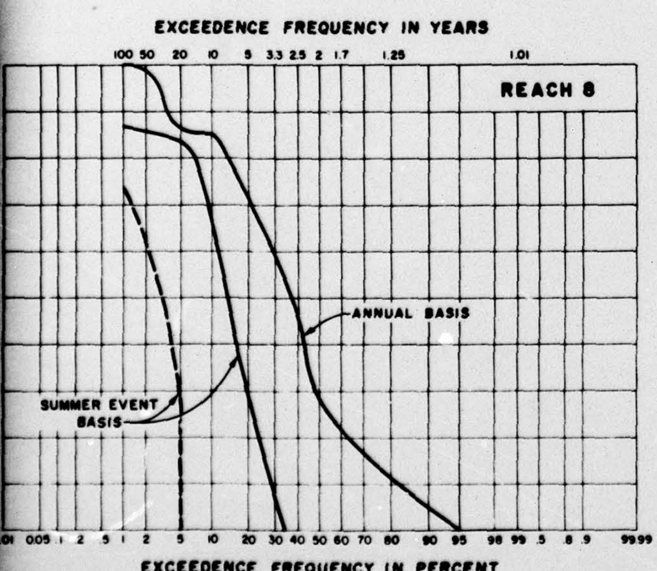
REACH 1
REACH 4
REACH 7
EXCEEDENCE FREQUENCY IN YEARS
EXCEEDENCE FREQUENCY IN PERCENT
AREA INUNDATED IN ACRES
ANNUAL BASIS
SUMMER EVENT BASIS
SUMMER EVENT
BASIS
THERE IS NO INUN
CONDITIONS FOR THE
DUE TO PLACING OF
LEFT BANK.











NOTES:

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INDEX POINT LOCATIONS

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REACH 6 - 100' UPSTREAM OF STATE ROUTE 258 ON STATE CANAL.

REACH 7 - 7200' DOWNSTREAM OF EVERMAN ROAD ON STATE CANAL.

REACH 8 - ON BRADNER CREEK 100' UPSTREAM OF EVERMAN ROAD.

LEGEND

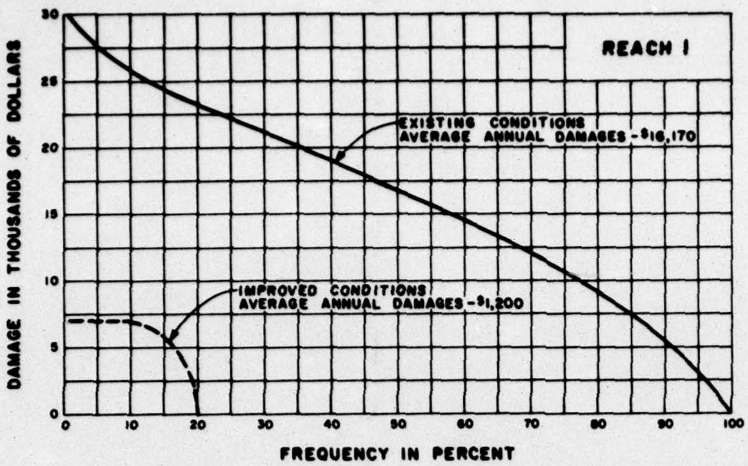
——— EXISTING CHANNEL CONDITIONS

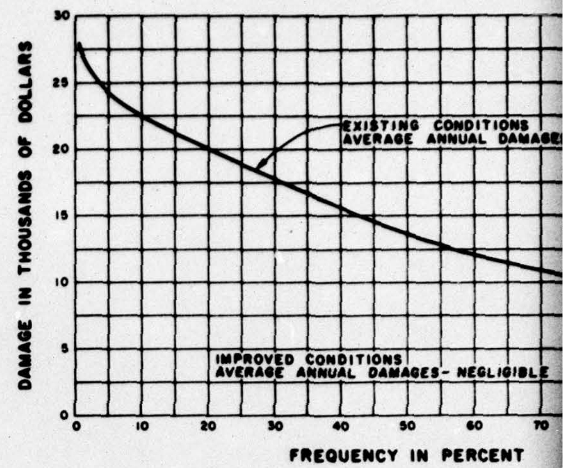
– – – IMPROVED CONDITIONS

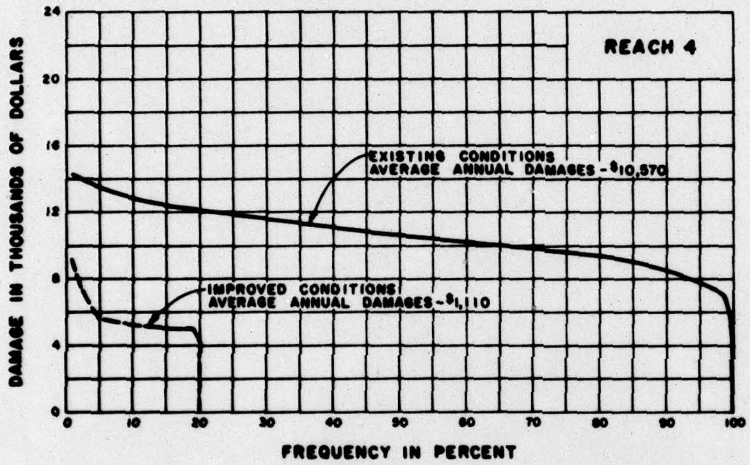
GENESEE RIVER BASIN
COMPREHENSIVE STUDY
NEW YORK AND PENNSYLVANIA
LOCAL PROTECTION PROJECT
CANASERAGA CREEK
LIVINGSTON COUNTY, NEW YORK

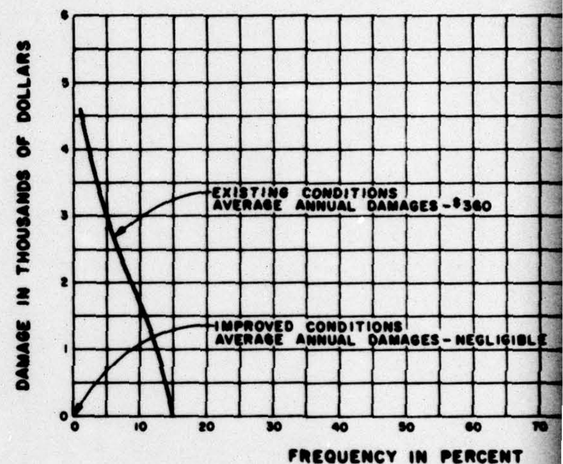
AREA INUNDATED FREQUENCY CURVES

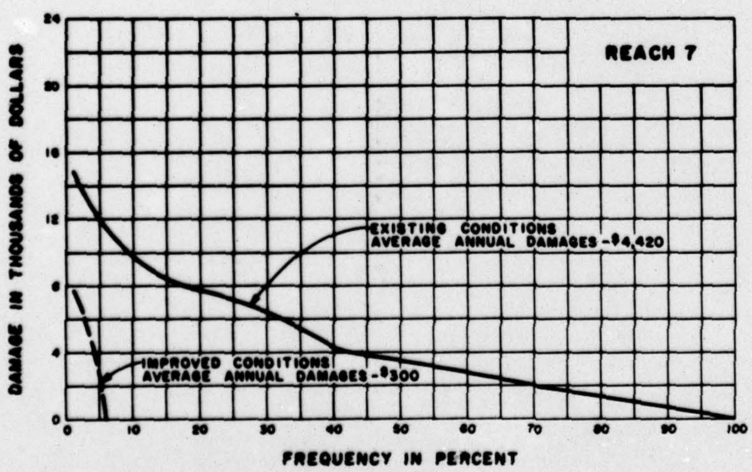
U.S. ARMY ENGINEER DISTRICT, BUFFALO
JUNE 1967

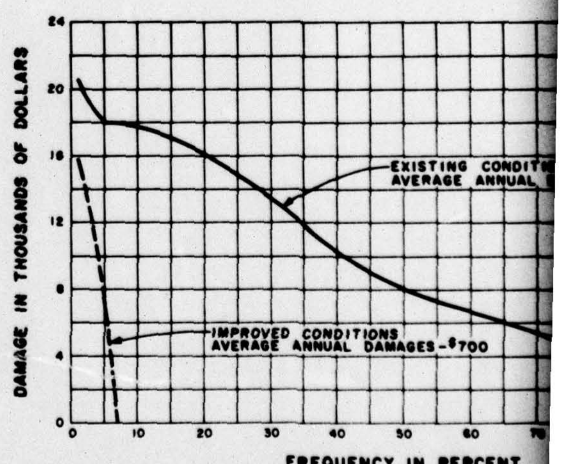

REACH 1
EXISTING CONDITIONS
AVERAGE ANNUAL DAMAGES - $16,170
IMPROVED CONDITIONS
AVERAGE ANNUAL DAMAGES - $1,200
DAMAGE IN THOUSANDS OF DOLLARS
FREQUENCY IN PERCENT

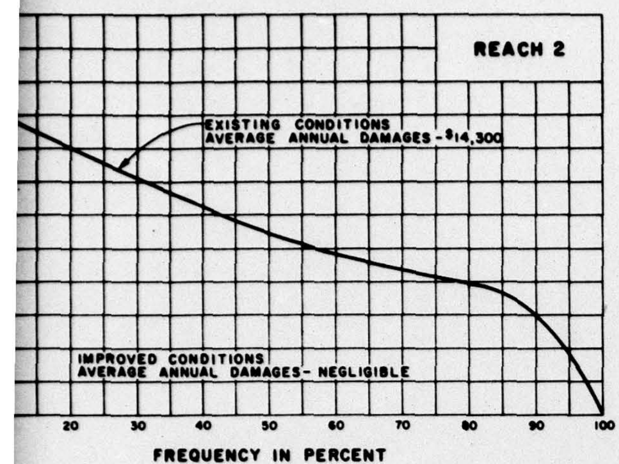

EXISTING CONDITIONS
IMPROVED CONDITIONS
AVERAGE ANNUAL DAMAGES - NEGLIGIBLE
DAMAGE IN THOUSANDS OF DOLLARS
FREQUENCY IN PERCENT

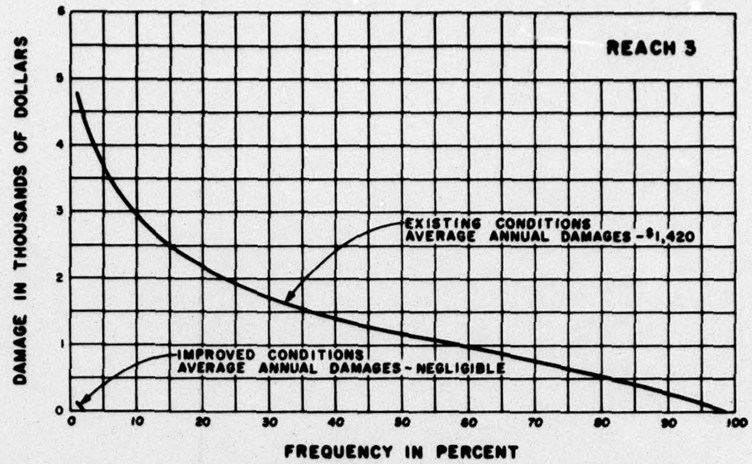

REACH 4
EXISTING CONDITIONS
AVERAGE ANNUAL DAMAGES - $10,570
IMPROVED CONDITIONS
AVERAGE ANNUAL DAMAGES - $1,110
DAMAGE IN THOUSANDS OF DOLLARS
FREQUENCY IN PERCENT

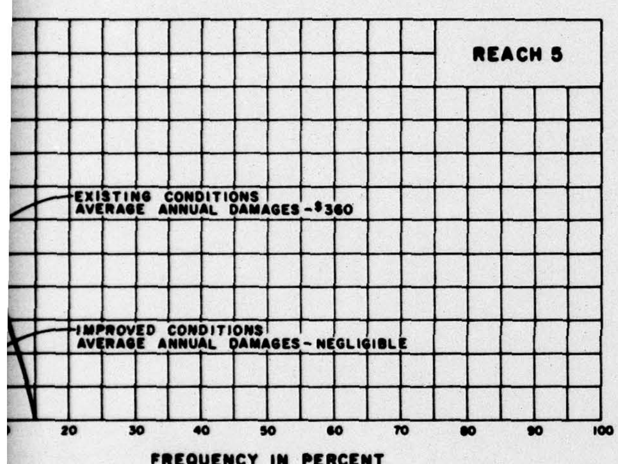

EXISTING CONDITIONS
AVERAGE ANNUAL DAMAGES - $360
IMPROVED CONDITIONS
AVERAGE ANNUAL DAMAGES - NEGLIGIBLE
DAMAGE IN THOUSANDS OF DOLLARS
FREQUENCY IN PERCENT

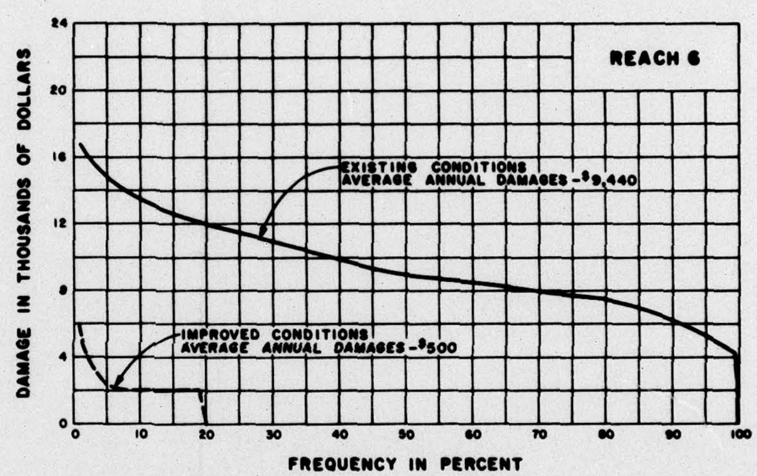

REACH 7
EXISTING CONDITIONS
AVERAGE ANNUAL DAMAGES - $4,420
IMPROVED CONDITIONS
AVERAGE ANNUAL DAMAGES - $300
DAMAGE IN THOUSANDS OF DOLLARS
FREQUENCY IN PERCENT

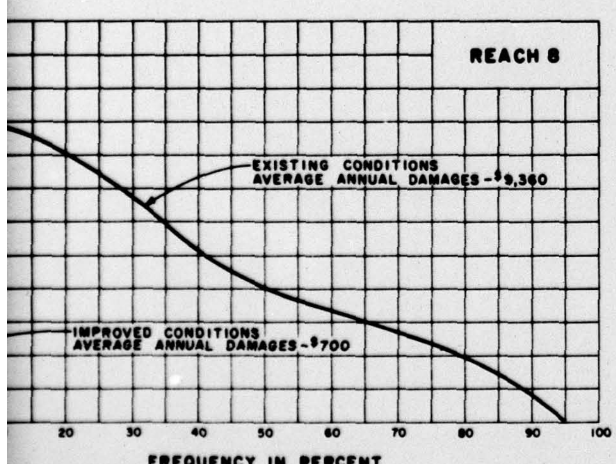

IMPROVED CONDITIONS
AVERAGE ANNUAL DAMAGES - $700
DAMAGE IN THOUSANDS OF DOLLARS
FREQUENCY IN PERCENT











NOTES:

REACHES SHOWN ON THIS PLATE ARE REFERRED TO DAMAGE REACH MAP, PLATE C15.

LEGEND

——— EXISTING CHANNEL CONDITIONS
— — — IMPROVED CONDITIONS

INDEX POINT LOCATIONS

REACH 1 - ON CANASERAGA CREEK 1600' DOWNSTREAM OF THE CONFLUENCE WITH KESHEQUA CREEK.

REACH 2 - ON CANASERAGA CREEK 1400' DOWNSTREAM OF THE CONFLUENCE WITH KESHEQUA CREEK.

REACH 3 - 100' DOWNSTREAM OF PIONEER ROAD AND 1500' EAST OF STATE ROUTE 36.

REACH 4 - 100' DOWNSTREAM OF STATE ROUTE 258 ON STATE CANAL.

REACH 5 - ON CANASERAGA CREEK APPROXIMATELY 3500' NORTH OF EVERMAN ROAD BRIDGE AND 50' UPSTREAM OF AN EXISTING FARM BRIDGE.

REACH 6 - 100' UPSTREAM OF STATE ROUTE 258 ON STATE CANAL.

REACH 7 - 7200' DOWNSTREAM OF EVERMAN ROAD ON STATE CANAL.

REACH 8 - ON BRADNER CREEK 100' UPSTREAM OF EVERMAN ROAD.

GENESEE RIVER BASIN
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FLOOD DAMAGE FREQUENCY CURVES

U.S. ARMY ENGINEER DISTRICT, BUFFALO
JUNE 1967